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NUCLEAR SCIENCE ABSTRACTS

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NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

13389 (ANL-6769) RADIOLOGICAL PHYSICS DIVISION SUMMARY REPORT, JULY 1962 THROUGH JUNE 1963. (Argonne National Lab., Ill.). Dec. 1963. Contract W-31-109-eng-38. 246p.

Research progress in radiological physics is reported in 22 papers and 5 abstracts of papers. Separate abstracts were prepared for each paper. (M.C.G.)

For abstracts of individual papers see: 13400, 13401, 13402, 13406, 13407, 13408, 13409, 13410, 13411, 13412, 13609, 13716, 13805, 13831, 14159, 14197, 14574, 14575, 14576, 14577, 14717, and 14756.

13390 (ORINS-43) MEDICAL DIVISION RESEARCH REPORT FOR 1963. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.). Contract AT-40-1-GEN-33. 109p.

Patients with chronic lymphatic or chronic myelocytic leukemia were exposed to whole-body single doses of 50 r γ radiation, and patients with lymphosarcoma were exposed to whole-body single doses of 100 r γ radiation. Clinical response and hematological data are reported. An evaluation was made of 95 patients with ovarian carcinoma treated with intraperitoneal radioisotope therapy. Preliminary data are presented from studies of amino acid metabolism in mouse radiation chimeras; viability studies on frozen human bone marrow; diffusion chamber cultivation of human lymph node tissue; antibody synthesis in cultured mouse tissues; the effects of whole-body γ irradiation on immune reactions and chimerism in the primate Tamarinus nigricallis; factors affecting the selective localization of Ce^{144} ceramic microspores or chelates and colloidal P^{32}- or Cr^{51}-labeled chromic phosphate after lymphatic injection in dogs; the induction of fatty liver in rats by intravenously injected chelates of Ce, Nd, or Sm; the distribution of Ba^{137} in rats; the use of I^{131}-hippuran in renal function tests; the effectiveness of intermittent corticosteroid therapy in malignant lymphatic diseases; and the development of a rapid method for the detection of vitamin B_{12} distribution using an arm counter and Co^{60} as a tracer. Design modifications are reported in radiation detection instruments for use as whole-body and single arm counters. (C.H.)

13391 (TID-20272) RADIATION DOSIMETRY OF RECENT AND FOSSIL MARINE INVERTEBRATES. Annual Progress Report. Noye M. Johnson (Dartmouth Coll., Hanover, N. H.). Feb. 29, 1964. Contract AT(30-1)-2982. 15p.

A thermoluminescent dosimeter was developed that measures both the quantity and the quality of γ radiation in the field. Applications are reported in ecological studies at the Brookhaven National Lab. γ forest. A study was made of the natural thermoluminescence of oysters ranging in age from modern to oligocene. The influence of biogenic calcite on thermoluminescence was investigated in limestone, volcanic rocks, and other geological specimens. The effects of uv, γ, and thermal radiation on natural thermoluminescence of oysters were studied in an attempt to explain thermal decay of the thermoluminescence and other thermoluminescent phenomena. (C.H.)

13392 MAN AGAINST SPACE. David Kerslake (R. A. F. Inst. of Aviation Medicine, Farnborough, Eng.). Discovery, 24: 30-5(Oct. 1963).

Some of the unfavorable environmental factors to be overcome before safety of manned space flight can be ensured are discussed. It will be necessary to provide simultaneously every aspect of a microclimate and to explore and counter the new problems of weightlessness, radiation, and psychology that arise in space. These factors, unique to space, cannot be fully reproduced on the ground, but they can be studied by a combination of partial simulation in the laboratory and very closely controlled orbital flights. The danger of exposure to radiation depends on the total dose received during exposure and on the interval between doses, during which partial recovery occurs. Within the van Allen belts and elsewhere in space during solar flares the intensity may be large enough to make mechanical shielding obligatory. In other circumstances damage might be restricted to an acceptable level by giving the crews appropriate rest periods between flights. Limited biochemical protection from radiation can already be given, and the situation may be improved even further by selecting as members of the crew only those people with the greatest resistance to radiation. However, it is doubtful whether any of these techniques can be sufficiently developed to make mechanical shielding unnecessary. In addition to radiation hazards, various other inimicable factors to man's well-being in the space environment are discussed. (BBB)

13393 THE C BLOOD GROUP SYSTEM IN PIGS AND THE DETECTION AND ESTIMATION OF LINKAGE BETWEEN THE C AND J SYSTEMS. E. Andresen and L. N. Baker (Ames Lab., Ames, Iowa). Genetics, 49: 379-86 (Mar. 1964).

A new red cell antigen, C_a, was detected in pigs of the Duroc breed, and a twelfth blood group system, the C system was established. Linkage between the C and J blood group loci has been detected by using all available data pertinent to linkage studies. The data are homo-

geneous with respect to the single-factor segregations and their joint segregation. Complete X or Y linkage has been excluded for both loci. Crossing over seems to occur with equal frequency in the two sexes. The recombination value of 5.3 percent ±1.1 percent was estimated by using the maximum likelihood method on the combined data. (auth)

13394 RECOMBINATION AND COMPLEMENTATION OF ALBINO MUTANTS IN NEUROSPORA. P. C. Huang (California Inst. of Tech., Pasadena). Genetics, 49: 453-69(Mar. 1964).

On the basis of recombination and complementation studies, 27 albino mutants of Neurospora crassa can be tentatively grouped into one or the other of two closely linked units. One of the units, represented by aur, consists of several recombinational subunits. The other, represented by al-2, contains only four mutants and also seems to be divisible. Many inter- as well as intra-unit combinations did not show complementation for the carotenoid pigments, but growth was observed in these forced heterokaryons. Such noncomplementarity is attributed to unbalanced nuclear ratio and functional incompatibility. Moreover, while the albino mutants contain only the colorless polyenes, complementing pairs produce in their heterokaryons a full spectrum of colorless and pigmented carotenoids that are ordinarily present in the wild types. The suggestion is made that these closely linked units are functionally heterocatalytic and the present material may be used to obtain a greater understanding of genic control of carotenogenesis. While the present result is not inconsistent with there being only one complex gene, in which two units resemble separate cistrons, the relevancy of interpretation at this level must rest on further understanding of the nature of complementation and noncomplementation and of the biochemistry of carotenogenesis. (auth)

13395 RESULTS AND FUTURE OF RADIOBIOLOGY. Hedi Fritz-Niggli (Universität, Zurich). Radiol. Clin., 32: 465-79(1963). (In German)

Radiobiology is defined and problems in it are discussed. Studies in radiobiology and results obtained are described. Relative biological effectiveness is considered. The role of environment is treated. Ideas concerning the radiation-effects chain are outlined. (M.C.G.)

13396 RASPREDELENIE, BIOLOGISESKOE DEISTVIE I MIGRATSIYA RADIOAKTIVNYKH IZOTOPOV. (Distribution, Biological Effects, and Migration of Radioactive Isotopes). A. V. Lebedinskii and Yu. I. Moskaleva, eds. Moscow, Medzig, 1961. 342p.

Forty-five articles are presented on the distribution, excretion, biological effects, and migration of radioisotopes (Cs^{137}, Sr^{89}, Sr^{90}, Ba^{140}, Ce^{144}, La^{140}, Ru^{106}, Pu^{239}, and Yt^{91}) in the biosphere. Papers are devoted to radioisotope distribution in animal organisms and factors influencing distribution, methods for accelerating excretion, peculiarities of radiation sickness, radioisotope effects on life span and tumor development, effective doses for producing acute, subacute, and chronical sickness, from temperature effects on complex formation, effects of splenectomy on the course of radiation sickness induced by Sr^{90} and Sr^{89}, radioisotope migration in biological chains, effects of strontium on microflora in water, mineralization of organic material, and sorption by ground water and sands. (R.V.J.)

13397 THE EPIDEMIOLOGY OF SALMONELLOSIS IN RELATION TO ITS TRANSMISSION BY FOOD AND FEED PRODUCTS. A. Granville (School of Veterinary Medicine, Brussels). p.9-34 of "Radiation Control of Salmonellae in Food and Feed Products." Vienna, International Atomic Energy Agency, 1963.

The occurrence of salmonellosis in animals and man is being considered, and on the basis of an extensive literature survey attention is drawn to the frequent presence of Salmonella in animals and man. The modes of contamination now believed important, particularly the part played by food and feed products and of water, are also reviewed. A survey is made of different existing methods for disinfection of such products. General measures of hygiene which should be observed to minimize the hazard of food poisoning by Salmonella are recalled. (auth)

13398 BACTERIOLOGICAL STUDY OF FISH MEAL IN PERU. A. Ramirez Miller (Ex-Escuela Nacional de Agricultura, Lima). p.53-60 of "Radiation Control of Salmonellae in Food and Feed Products." Vienna, International Atomic Energy Agency, 1963.

The importance of fish-meal production in Peru is pointed out, and the methods of manufacture are described. The bacteriological status at different stages of the fish-meal production process is reviewed. It is stated that the bacterial count of fish meal is related to the bacterial count of the fish pools, the environmental sanitation in ship holds and factories and the method of preserving the fish meal. (auth)

13399 BIOCHEMICAL PRINCIPLES OF THE FOOD INDUSTRY. V. L. Kretovich and E. Pijanowski, eds. Proceedings of the Fifth International Congress of Biochemistry, Moscow, 10-16 August 1961. Volume VIII. A Pergamon Press Book. International Union of Biochemistry Symposium Series. Vol. 28. New York, The Macmillan Company, 1963. 326p.

Various problems in the biochemistry of food production were considered as follows: biochemical foundations of agricultural plant and microorganism selection; biochemical foundations of grain, fruit, and vegetable preservation and treatment; biochemical foundations of milk and meat processing; and biochemical foundations of fermentation product treatment. Twenty-seven papers were presented; separate abstracts were prepared for four. (H.M.G.)

For abstracts of individual papers see: 13528, 13529, 14307, and 14308.

Ecology

13400 (ANL-6769(p.59-65)) THE Pb^{210}(RaD) CONCENTRATIONS OF SOME BIOLOGICAL MATERIALS FROM ARCTIC REGIONS. Richard B. Holtzman (Argonne National Lab., Ill.).

Data are presented on the Pb^{210} content of some biological specimens from the Arctic, namely, lichens from Finland and Alaska; the stomach contents (rumen, mostly lichens) of some caribou; a Finnish water plant used for fodder (Equisetum flaviatile); antler, meat, and bone from reindeer and caribou, and bones from an Icelandic lamb. For comparison some measurements of grass from Chicago are also shown. The Pb^{210} concentrations in lichens appeared to be higher than Po^{210} concentrations in grass. Concentrations of Pb^{210} in reindeer and caribou meat ranged from 0.174 to 0.366 pC/g dry or 0.06 to 0.09 pC/g wet, values more than 10 times the value of 0.007 pC/g wet of U. S. midwestern steer meat. Pb^{210} contents were higher in femurs than in antlers. (M.C.G.)

13401 (ANL-6769(p.75-8)) THE LEVEL OF RADIUM IN HUMAN BLOOD FORTY YEARS AFTER INGESTION. H. F. Lucas, Jr., J. H. Marshall, and L. A. Barrer (Argonne National Lab., Ill.).

Samples of whole-blood, cell-free serum, and cells containing some serum were obtained from four former New Jersey dial painters. Urine and fecal samples were also obtained. The whole-body Ra^{226} content was determined. Breath radon samples were taken. Results are presented in tables. (M.C.G.)

13402 (ANL-6769(p.79-89)) NORMAL FLUORIDE CONCENTRATION IN HUMAN BONE. F. H. Ilcewicz, H. F. Lucas, Jr., and Richard B. Holtzman (Argonne National Lab., Ill.).

Measurements were made of the fluoride concentration in portions of femur, rib, and vertebra from 109 individuals. Although residential, and hence fluoride exposure, histories were not complete, it was found by comparison of these measurements with those of other investigators that no individual consumed amounts greater than those normally found in food and local drinking water. An increase of fluoride concentration with age was noted in this and other studies. The data from all investigators (180 individuals) was combined in a single figure, and a linear increase with age was chosen since no other was apparent from the data or required by theory. A linear least squares fit by an equation of the form $F = a + bt$ was used, where a and b are constants, t is the age in years, and F is the ppm fluoride in the bone ash. The least squares fit of the data of other investigators and of this study gave nearly identical results. The equation $F = (288 \pm 83) + (12.9 \pm 1.7)t$ was obtained from the combined data. From the slope of this equation and from the average daily fluoride intake of 0.5 to 1.0 mg, it is estimated that uptake and retention by the skeleton is 10 to 20% of the intake. In addition, the average fluoride concentration at age 65 of 1200 ppm and the maximum reported in humans of 8700 ppm corresponded to 3.2 and 23% of the maximum attainable. Consequently fluoride, even at these low levels of intake, cannot be considered a trace element and may, in fact, have a significant influence on bone kinetics. Fluoride was found in the bone from three human fetuses. The mean concentration of 103 ppm demonstrated that transfer across the placenta occurs and that apparently some discrimination occurs since this value ($P < 0.03$) was significantly different than the 288 ± 83 ppm found by a least square analysis of the data as a whole. Samples of femur or tibia were obtained from 32 individuals having a verified osteogenic sarcoma and from 16 individuals having a similarly debilitating bone disease. These two groups were not well correlated in age, and direct comparison even for age-matched samples was not significant. It was apparent, however, that uptake and retention of fluoride by individuals having an osteogenic sarcoma was not significantly different from that for any other person. Although a correlation between the Ra^{226} and the fluoride concentration was found for certain well waters in Illinois, few of the individuals in this study consumed water from these sources. In addition the only source of fluoride for many of the subjects was that in their food so that no correlation was to be expected and none was found. Variations by as much as a factor of two in the fluoride concentration of different bones from the same individual were found in this as well as in previous studies. Significantly higher fluoride concentrations were found in vertebra than were found in either iliac crest or rib. In this study, in contrast with other studies, the concentration in the vertebra was not different from that in the rib. However, not all of these samples were from the same geographical region, and no significance is attributed to the difference. (auth)

13403 (HW-SA-2977) STRONTIUM-90 IN THE 1959 WHEAT CROP IN IDAHO AND MONTANA IN RELATION TO PHYTOCLIMATIC REGIONS. W. H. Rickard (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Apr. 4, 1963]. Contract AT(45-1)-1350. 8p.

Strontium-90 content of the 1959 Idaho and Montana wheat crop was distributed according to phytoclimatic regions. Spring precipitation during the most active part of the wheat growing season probably accounts for the higher strontium-90 content of grassland grown wheat as compared to sagebrush region wheat. Spring precipitation alone did not seem sufficient to account for the high strontium-90 content of wheat grown in coniferous forest regions. (auth)

13404 (TID-7677(p.392-400)) CONTROLLED ENVIRONMENTAL RADIOIODINE TESTS (CERT) AT THE NATIONAL REACTOR TESTING STATION. Earl H. Markee, Jr., and C. A. Hawley, Jr. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho).

I^{131} gas was released over a natural Crested Wheatgrass pasture. The contaminated grass was used for grazing milch cows and the resultant radioactive milk was fed to seven human volunteers. A total of 970 mC was released. A dense sampling grid was established to 300 m downwind. About 13% of the total released iodine was deposited on the grid, with 1.5% being actually on the grass. The effective half life on grass was found to be 3.5 days. The ratio of activities of grass and milk (pC/l : pC/g) was 240 ± 35. The average thyroid uptake of ingested I^{131} in milk was 19%. Thyroid doses to the volunteers averaged 0.39 rad. (M.C.G.)

13405 RADIOACTIVE SUBSTANCES IN THE FEATHERS OF BIRDS OF PASSAGE. H. Schildmacher. Kernenergie, 7: 59(Jan. 1964). (In German)

Birds were studied for the presence of radioactive materials in a lead chamber with a β-γ counter. In all cases the total activity was found in the feathers as small particles trapped among them. (M.C.G.)

Metabolism, Tissue Distribution, and Toxicology

13406 (ANL-6769(p.66-74)) THE CONCENTRATION OF Ra^{226}, Ra^{228}, Pb^{210}, LEAD AND FLUORIDE IN HUMAN BONE FROM INDIVIDUALS WITH AN OSTEOGENIC SARCOMA. H. F. Lucas, Jr., Richard B. Holtzman, and D. C. Dahlin (Argonne National Lab., Ill.).

Contents of Ra^{226}, Ra^{228}, Pb^{210}, lead, and fluoride in human bone in individuals with osteogenic sarcoma were determined. Uninvolved bone was obtained from the area adjacent to the tumor. The mean Ra^{226} and Ra^{228} concentrations were 0.028 ± 0.016 and 0.007 ± 0.004 pC/g ash, respectively, and the Pb^{210}, stable lead, and fluoride concentrations were 0.080 pC/g ash and 17 and 411 μg/g ash, respectively. The overall metabolism of radium in patients with an osteogenic sarcoma did not appear to be significantly different from that in other individuals. The internal dose rate and the metabolism of Pb^{210}, stable lead, and fluoride also did not differ significantly from those for average human beings. (M.C.G.)

13407 (ANL-6769(p.90-111)) THE KINETICS OF ALKALINE EARTH METABOLISM IN ANIMALS. I. BASIC PRINCIPLES. Richard B. Holtzman (Argonne National Lab., Ill.).

It is shown that the mathematical description of calcium and calcium tracer metabolism is analogous to a relatively simple chemical system. Derivation of the power function for the case of single injection and retention in solid and for the case of continuous uptake is described. The theory and mechanism are discussed; they do not preclude modification of the description by biological factors. (M.C.G.)

13408 (ANL-6769(p.112-16)) THE KINETICS OF ALKALINE EARTH METABOLISM IN ANIMALS. II. EXTENSION OF CONCEPTS. Richard B. Holtzman (Argonne National Lab., Ill.).

Mathematical descriptions of calcium metabolism were extended and applications of these principles were established. The retention function with competing reactions is discussed. (M.C.G.)

13409 (ANL-6769(p.127-40)) CRYSTAL GROWTH — A NEW PHYSICAL APPROACH TO THE DEPOSITION OF RADIOACTIVE ISOTOPES IN BONE. David N. Edgington (Argonne National Lab., Ill.).

It is shown that the representation of in vitro results for deposition of radioisotopes in bone by a power function can be rationalized in terms of well-established physical-chemical principles. It was found that there are two physical descriptions of the power function that are in good agreement with the observed experimental facts: an interpretation based on chemical kinetics and an interpretation based on crystal growth theory. Extension of the theory to in vivo systems is discussed. (M.C.G.)

13410 (ANL-6769(p.142-9)) PERIODICITY OF MITOSIS. S^{35}-SULFATE AND C^{14}-GLYCINE UPTAKE IN RAT BONE. David J. Simmons (Argonne National Lab., Ill.).

Experiments designed to detect daily changes in the functional activity of cartilage and bone cells by the use of S^{35}-sulfate as an index of chondroitin sulfate synthesis, and of C^{14}-glycine to show collagen synthesis are described. Studies were made on albino rats. Data for S^{35} incorporation in the femur revealed that differences in the pattern for incorporation occurred only in the distal growth cartilage. The articular and epiphyseal cartilage appeared rather uniformly labeled with C^{14} except for the more intense reaction over the lateral edges of the epiphyseal cartilage where the width of the plate is increased as the bone grows larger. Evidence was obtained that the processes of bone and cartilage formation operate against a background of diurnal periodic changes. (M.C.G.)

13411 (ANL-6769(p.150-64)) THE POSTNATAL DEVELOPMENT OF BONE OF JAPANESE QUAIL. I. THE CORTEX. David J. Simmons and Arsen M. Pankovich (Argonne National Lab., Ill.).

The development of the long bones of Japanese quail was studied histologically and microradiographically at different post-hatching periods from birth to one year of age. At the level of the mid-shaft, the woven bone of the neonatal animal became thicker by rapid periosteal growth and became consolidated by the deposition of bone within large vascular spaces throughout the first month of life. Continued periosteal growth and formation of osteons was most rapid during the second and third month, and the mature architecture of the cortex, primary haversian bone, was established at the end of this period. Osteon formation was more progressive in the tibiotarsus and tibia than in the femur. Replacement osteons were established by remodeling endochondral bone incorporated into the metaphyses near the endosteum, but these deposits delimited by cement lines did not seem to be remodeled to any significant degree. Resorption cavities were frequently observed in highly mineralized interstitial lamellae. (auth)

13412 (ANL-6769(p.165-79)) THE POSTNATAL DEVELOPMENT OF BONE OF JAPANESE QUAIL. II. THE EFFECT OF ESTROGEN. David J. Simmons and Arsen M. Pankovich (Argonne National Lab., Ill.).

The bone changes coincident with the onset of reproductive maturity in a small avian species, the Japanese quail (Coturnix coturnix japonica) and the effects of estrogen administered to both females and males at different post-hatching intervals are described. The normal cortex of 30- to 35-day-old birds consisted of woven lamellar bone enclosing a reticular network of large vascular spaces that open at the periosteum and endosteum, with maybe a few endosteal primary longitudinal canals. This anastomotic vascular nonhaversian pattern was somewhat reduced in the femora of birds receiving estrogen. There was no apparent structural changes in the tibial cortex owing to estrogen treatment. The onset of normal age changes in the medullary cavity of female quail were dependent on the time at which hormone treatment was begun. Microradiographs are shown. (M.C.G.)

13413 (BNL-7317) THE SIMULTANEOUS LABELING OF CELLS IN DIFFERENT SEGMENTS OF THE MITOTIC CYCLE WITH TRITIATED THYMIDINE AND COLCHICINE AND THE EFFECT OF COLCHICINE ON THYMIDINE UPTAKE. J. Van't Hof and Huei-Kuen Ying (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 28p.

Treatment of Pisum root meristems with nutrient solutions containing tritiated thymidine (H^3-T) and colchicine simultaneously labeled cells in two different segments of the mitotic cycle. Tracings of the serial progression of these differently labeled cells through mitosis resembled sine-cosine curves. When the labeled cells are in interphase the sign of the curves is negative, when they are in mitosis the sign is positive. The concept of the mitotic cycle in terms of trigonometric functions was presented as one way of transferring the cycle from a celestial time scale to that of a biological clock. The mitotic cycle time determined by the colchicine method was 14 hours at 20°C. The cycle time was 14.25 hours if the ascending portions of a curve representing two successive appearances of H^3-T labeled mitotic figures was used as a measurement. Use of the proportion of H^3-T labeled interphase cells and the S period duration produced a cycle time of 21.4 hours. The doubling of DNA content by colchicine did not increase the cycle time. Colchicine did prevent the H^3-T labeling of a large number of late S period cells when the two labels were either presented to meristems simultaneously or if colchicine treatment preceded H^3-T exposure. The use of colchicine and H^3-T as cellular labels and the kinetic variables on which they depend were also discussed. (auth)

13414 (BNL-7362) NEUTRON ACTIVATION ANALYSIS: CLINICAL AND BIOLOGICAL STUDIES OF MANGANESE. G. C. Cotzias, P. S. Papavasiliou, and S. T. Miller (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT(30-2)-Gen-16. 28p. (CONF-384-2)

From Symposium on Radioactivation Analysis and its Application to the Biological Sciences, Saclay, France, Sept. 1963.

The use of neutron activation analysis for studying the

metabolism of manganese in the body is discussed. Results of various clinical and biological studies of manganese metabolism are described. Some of the results indicate that pigments (melanin) in general contain high manganese concentrations and might play a role in extrapyramidal diseases. (D.L.C.)

13415 (CEA-2381) METABOLISME ET TOXICOLOGIE DU PLUTONIUM 239— EVALUATION DE LA CONTAMINATION INTERNE DES PERSONNES PROFESSIONNELLEMENT EXPOSEES. (Metabolism and Toxicology of Plutonium-239— Evaluation of the Internal Contamination of Persons Professionally Exposed). Ph. Henry (France. Commissariat à l'Énergie Atomique. Centre de Production de Plutonium de Marcoule, Chusclan). 1963. 46p.

After reviewing the main metabolic and toxicological properties of plutonium 239 as well as the professional norms now in force, the report considers the difficult problem of the evaluation of the internal contamination of persons professionally exposed. The evaluation is dependent on the practical organization of the supervision involved: systematic supervision by periodic analysis of urinary Pu and special supervision in the case of incidents by an examination adapted to each case. A simple interpretation of the systematic analyses, as well as the evaluation methods used in the main cases of accidental contamination are outlined. (auth)

13416 (CONF-355-4) CALCIUM TURNOVER STUDIES IN MAN. K. R. Corey, D. Weber, M. Merlino, D. Greenberg, P. Kenny, and J. S. Laughlin [Sloan-Kettering Inst. for Cancer Research, New York]. [1963]. Contract AT(30-1)-910. 29p.

Methods for determination of calcium turnover in man with radioisotopes are presented and the clinical use of various techniques is evaluated. In the discussion of kinetic analyses, some important observations were made. The accretion rate calculation can be made independent of the number of compartments in the exchangeable calcium pool, and thus is not distorted by approximate estimations of this pool. However, if the exchangeable calcium pool is calculated with the isotope dilution technique, and the accretion rate obtained from this value by the total turnover equation, then an error is introduced into the value of the accretion rate. It was also pointed out that the multicompartment treatment is more appropriate than the customary single compartment analysis and utilizes all available information. Since the pool size has been of little clinical use so far, it was suggested that multicompartment analyses be used in the future. At present, no accepted model exists which can account for all data obtained in tracer studies and in particular for the last part of the serum disappearance curve. Preliminary results of long term studies of the retention in bones of strontium-85 was presented. These show that there is measurable turnover of tracer deposited in bone even several months after injection. (auth)

13417 (KR-63) TAGGING OF HUMAN RED CELLS WITH CHROMIUM-51. O. R. Birkelund and J. B. Dahl (Norway. Institutt for Atomenergi, Kjeller). Jan. 1964. 23p.

The uptake of chromium-51 from our production by human red cells was investigated in relation to properties of the chromium-51 product, such as age, total chromium content, amounts of three- and hexavalent-chromium, and in relation to properties of the blood sample, such as age, hemoglobin content, and chemical effects of anticoagulent agent. The age of the blood sample has proved to be a dominant factor for the uptake of chromium by human red cells. (auth)

13418 (TID-13636) STUDY OF THE HEALING OF CORNEAL WOUNDS WITH RADIOACTIVE ISOTOPES, WITH SPECIAL REFERENCE TO THE PLASTIC ARTIFICIAL CORNEA. Final Report. William Stone, Jr. and Seymour Zigman (Harvard Univ., Boston. Massachusetts Eye and Ear Infirmary). [1959]. Contract AT(30-1)-1905. 29p.

The ribonucleic acid (RNA) and deoxyribonucleic acid (DNA) content of corneal epithelium and corneal stroma were measured, the RNA was separated into its component nucleotides, and the uptake of P^{32} (phosphate) into the nucleic acids was determined. Phosphorus-containing compounds of rabbit, calf, and dogfish corneas were extracted by a modification of the Schmidt-Thannhauser procedure. Hot 10% NaCl was then used to extract the nucleic acids from the defatted and acid-precipitated tissues. After the RNA and DNA were precipitated by cold 95% ethanol and separated by hydrolyzing the RNA with dilute KOH, the products of this extraction were lyophylized and ultraviolet absorption studies, phosphorus analyses, and sugar tests were performed. For the epithelial tissue, sugar tests and ultraviolet absorption spectra showed characteristics of RNA and DNA; no such characteristics emerged for stromal tissue. A system was developed whereby labeled nucleic acid precursors were incorporated into the RNA and DNA of incubated corneas. Studies of the in vitro uptake of P^{32} (phosphate) by the cornea revealed that epithelial RNA and DNA fractions contained radioactivity after incubation. Radioactivity was detected in the stroma, but the P^{32} (phosphate) could not be identified as RNA or DNA. Paper-electrophoretic separations of corneal epithelial ribonucleotides showed that P^{32} (phosphate) was incorporated into all four nucleotides during a two-hour incubation in Krebs-Ringer-bicarbonate medium. The relative amounts, specific activities, and nucleotide ratios of nucleic acids present differentially in epithelium and stroma of calf, rabbit, and elasmobranch normal corneas are shown. Results indicate that in the normal cornea at least, the epithelium has little effect on the nucleic acid or the phosphorus metabolism of the stroma. (auth)

13419 (TID-20242) A STUDY OF THE ABSORPTION AND METABOLISM OF LIPIDS AND VITAMINS AND THE ALTERATIONS WHICH OCCUR IN ACUTE RADIATION INJURY. Final Report. John G. Coniglio and William J. Darby (Vanderbilt Univ., Nashville. School of Medicine). Oct. 31, 1963. Contract AT(40-1)-1033. 22p.

Data are summarized from studies on the effects of acute radiation injury on intestinal absorption and metabolism of lipids and vitamins in rats and monkeys. The effects of diet, age, and sex were investigated using C^{14}-labeled lipids as tracers. Basic aspects of metabolism of lipids and vitamins, the relation between carbohydrates and lipid metabolism in brain and testes before and after whole-body x irradiation were investigated. A list is included of publications resulting from work performed under this contract. (C.H.)

13420 THE EFFECT OF IONIZING RADIATION UPON SULFUR METABOLISM. Jan Neuwirt (Charles Univ., Prague). Acta Univ. Carolinae, Med., 7: 301-28(1961). (In Czech)

The effect of ionizing radiation on protein sulfhydryl groups was investigated in Wistar rats. The animals were exposed to 600-r doses of 200-kv whole-body x irradiation and at various intervals (4 and 24 hr and 4 days) changes in proteins in testis and spleen were examined. In some cases S^{35}-labeled amino acids had been injected in the rats. Non-

protein nitrogen levels rose approximately 75% at 4 hr but had returned to normal four days postirradiation. The cystine plus glutathione and lysine contents of the tissues rose approximately 50% 4 hr after exposure. Protein-bound sulfhydryl groups increased in both tissues immediately after irradiation, presumably due to splitting of protein disulfide groups. Some S is also split from the protein molecule by irradiation. This splitting of protein S is manifested by an increase of the nonprotein S in the radiosensitive tissues. Simultaneously the protein S decreases. In proteins labeled with S^{35} before irradiation, the specific activities of protein S decreased immediately after exposure. In the first hours after exposure in radiosensitive tissues, also a significant reduction of the incorporation of S-containing amino acids into the tissue proteins was noted. Using the labeled amino acids methionine and cysteine, it was shown that the increased excretion of S after irradiation originates only from the S split from proteins. Ionizing radiation inhibited the utilization of methionine by the liver. The unique radio-sensitivity of protein-bound S is discussed. (BBB)

13421 EXAMINATION OF SOME ENZYMATIC ACTIVITIES IN THE LIVER AND KIDNEY OF THE MOUSE BEFORE AND AFTER ADMINISTRATION OF CARBON TETRACHLORIDE OR URANYL NITRATE. Anny Alibert, Marie-Thérèse Rigal, Pierre Bastide, Jean-Pascal Turchini, and Gaston Dastugue (Faculté Mixte de Médecine et de Pharmacie, Clermont-Ferrand, France and CNRS, Paris). Compt. Rend. Soc. Biol., 157: 1439-41(1963). (In French)

A general outline is given of the preliminary results obtained in the examination of enzymatic activities in mouse liver and kidney before and after administration of carbon tetrachloride or uranyl nitrate. Renal and hepatic lesions were observed after the administration. The principal variations in the phosphatase activities are defined and interpreted. (J.S.R.)

13422 EFFECT OF THE RADIOACTIVITY FACTOR ON THE DISTRIBUTION OF COLLOIDAL CHROMIUM RADIOPHOSPHATE INJECTED INTRAVENOUSLY IN THE RAT. A. Chevallier, F. M. Jacques, and R. Stanghellini (Institut de Physique Biologique, Faculté de Médecine, Strasbourg and Centre Paul Strauss, Strasbourg). Compt. Rend. Soc. Biol., 157: 1494-8(1963). (In French)

The phenomena resulting from the intravenous injection of colloidal P-32 labeled $CrPO_4$ in rats were studied at various intervals after injection, from 24 hrs to 50 days. Any possible effect that the radiation emitted might have on its location was investigated at the site levels. Doses of 30, 60, 120, and 150 μC per animal were administered. It appears that, apart from the decrease in weight of the spleen which reflects on the activity of the splenic tissue considered per unit mass, the radiation of particles fixed at the level of the spleen, the bone marrow, and the lung can affect the reticulo-endothelial tissue itself when the activity reaches a high level. This effect is shown by a liberation of particles which, taken up by the circulation, are then fixed by hepatic tissue. It can be assumed that these are the cells that have phagocytosed radioactive colloidal granules and have received sufficient radiation to destroy them. The radiation doses capable of causing this are very high. (J.S.R.)

13423 TOXIC PROPERTIES OF RARE AND NON-COMMON METALS. Karel Vetejška. Chem. Listy, 57: 711-22(July 1963). (In Czech)

The toxicological problems and industrial hygiene safeguards involved in the production and handling of the rarer metals, such as Ti, Zr, Mo, and W, which are of considerable industrial importance, and of the somewhat less important V, Ce, Nb, Ta, Cs, Ba, and Be are reviewed. While the first-mentioned elements are produced at rates of tens of thousands of tons, others, such as Th, In, Ga, Ge, and Re are of great industrial importance, although their production rate is comparatively small. In order to protect workers, safe values were established in various countries. The various pertinent values, such as concentration in air, are discussed and the individual dangers presented by the metals are pointed out. (Review article, 56 references). (TTT)

13424 STUDIES ON THE STIMULATION OF THYROIDAL INORGANIC ^{127}IODIDE RELEASE IN VITRO BY THYROTROPIN. Richard C. Powell, M. Ataur Rahman and William P. Deiss, Jr. (Indiana Univ., Indianapolis). Endocrinology, 74: 395-407(Mar. 1964).

When beef thyroid slices were incubated with thyrotropin (TSH), inorganic iodide^{127} accumulated in a rectilinear fashion for up to 8 hr of incubation, whereas little change was noted in controls. An oxygen atmosphere was essential for this effect. The log-dose response curve was biphasic, with hormone concentrations ranging from 0.01 to 100 mU/ml incubation medium. Maximum increases in stable iodide were achieved at 1 mU/ml TSH levels. Thiourea and/or perchlorate did not alter this biphasic response. TSH inhibited the protein binding of added radioiodide after 5 hr of incubation, although slice uptake was not impaired. Again the dose response was biphasic, with 1 mU/ml concentrations appearing to be most effective. In shorter incubations, however, the larger TSH doses increased radioiodine organification. Deiodination per se, as measured by the accumulation of radioiodide from diiodotyrosine-I^{131} in the presence of an excess of added carrier diiodotyrosine, was not stimulated by TSH. The data indicate that TSH concentration and/or incubation time markedly alter stable iodide accumulation and radioiodine organification. It is further concluded that the observed accumulation of inorganic iodide^{127} is a result of TSH-augmented proteolysis of thyroglobulin. (auth)

13425 USE OF THE ERYTHROCYTE T3-^{131}I UPTAKE TEST FOR EVALUATING THYROID FUNCTION IN RATS. ITS APPLICATION TO A STUDY OF THE EXTRATHYROIDAL ACTION OF PROPYLTHIOURACIL. Krishna M. Saxena, John D. Crawford, and Maragret H. MacGillivray (Massachusetts General Hospital, Boston). Endocrinology, 74: 415-20(Mar. 1964).

The Hamolsky erythrocyte T3-I^{131} uptake test was modified to permit use of reduced volumes of arterialized blood and was found to be a reliable index of metabolic status in rats suitable for performing serial evaluations of individual animals. Results of the erythrocyte T3-I^{131} uptake test, together with observations of activity and growth and determination of gland weight, I^{131} gland uptake and serum protein-bound iodine (PBI) in rats given T3, T4 and propylthiouracil (PTU) suggest that PTU almost fully inhibited the metabolic effects of daily doses of 10 μg of T4 but had little effect on response to 5 μg of T3. The erythrocyte T3-I^{131} uptake in contrast to the PBI showed direct correlation with clinical evaluation of the animals' metabolic status. (auth)

13426 THE CONCENTRATION OF COMMON POTASSIUM, RUBIDIUM AND CESIUM IN JAPANESE DIET. Noboru Yamagata (Inst. of Public Health, Tokyo). J. Radiation Res. (Japan), 3: 158-69(Sept. 1962).

Measurements were made of potassium, rubidium, and

cesium in a variety of Japanese diet samples to study the fate of these elements in the food chain. Each component of the diet contributes potassium evenly to the diet, however, almost half of cesium is estimated to be contributed by meat, eggs, and milk products. Thus, the daily intake of cesium varies greatly depending on the dietary intake of this component. The daily intake by the Japanese adults as a whole is estimated as 1.4 g of potassium, 1.5 mg of rubidium, and 0.01 mg of cesium per person. The biological half lives are estimated as 54, 140, and 76 days, respectively, for potassium, rubidium, and cesium on the basis of the balance between the human body and diet assuming a single exponential function of excretion. (auth)

13427 INFLUENCE OF CALCIUM AND STRONTIUM CARRIERS FOR RADIOACTIVE STRONTIUM DEPOSITION IN BONE. Hajime Nishioka (Tokyo Inst. of Tech.), Yoshiko Kato, and Yasushi Nishiwaki. J. Radiation Res. (Japan), 3: 170-6(Sept. 1962).

The influence of stable carriers on the deposition of radioactive strontium in the bone was investigated. The deposition of calcium-45 or strontium-89 was observed to depend on the solubilities of their salts at the time of administration. Therefore, the concentrations of radioactive strontium in bone calcium were calculated on the basis of calcium content in soluble fraction of foods. The interference of calcium carrier on the deposition of strontium-89 in rat femurs could be recognized only under the calcium deficient condition. Using tissue culture of chick embryonic bone, the uptake of strontium-89 was evidently depressed by the addition of strontium carrier in the medium rather than by calcium carrier. (auth)

13428 CESIUM-137 IN JAPANESE PEOPLE AND DIET, FEB. 1960-MAY 1962. Noboru Yamagata (Inst. of Public Health, Tokyo), Kiyoshi Kodaira, and Hiroshi Hayami. J. Radiation Res. (Japan), 3: 182-92(Sept. 1962).

Measurements were made of the cesium-137 content in human muscle, total diet, and cereals collected in Japan during the period from February 1960 to May 1962. The simple methods of evaluation of mean levels in the human body proposed are based on distribution studies on the common cesium irrespective of potassium concentration or the cesium unit. The total body burden was estimated as 3.2–4.0 mμC for the period from August 1960 to January 1962 and it rose up to 7.6mμC in March 1962 in correspondence with the increased fallout deposition rate in Autumn 1961. The daily intake of cesium-137 by Japanese people was 29 μμC, on average, for the period from August 1960 to August 1961 and increased to 50 μμC in February 1962. The contribution of cesium-137 by cereals to the total intake was estimated as approximately 40% for the period from November 1960 to November 1961 and it decreased to 32% in February 1962. The relative decrease was attributed to the increase in the daily intake, probably other than cereal, through leafy vegetables. (auth)

13429 BALANCE OF COBALT IN JAPANESE PEOPLE AND DIET. Noboru Yamagata (Inst. of Public Health, Tokyo), Wumiko Kurioka, and Toshi Shimizu. J. Radiation Res. (Japan), 4: 8-15(Mar. 1963).

Measurements were made of the stable cobalt in total diet samples collected from a number of sites to know the normal daily ingestion of this element by average Japanese. Two thirds of Japanese adults should take 11-28 μg of cobalt daily and rural children, a half or less amount. The main contributors of cobalt in Japanese diet are plant products. Their contribution as a whole was estimated up to 88.2% of the total intake. Biological half-life of radiocobalt was estimated as 106 days (fw: 0.3) or 29.3 days (fw: 0.92) for Japanese on the basis of assumed existence of an equilibrium condition between the stable element and radiocobalt. Estimation of the daily intakes by Japanese of Co^{60} through marine and land products was also attempted in the assumed situation of environmental contamination of sea-water and soils. (auth)

13430 TRANSFER OF RADIOCESIUM INTO HEN'S EGGS FOLLOWING SINGLE AND DAILY ORAL ADMINISTRATION. Akiko Horiuchi and Ryushi Ichikawa (National Inst. of Radiological Sciences, Chiba City, Japan). J. Radiation Res. (Japan), 4: 26-30(Mar. 1963).

Relation between radiocesium content in hen's eggs and their diet was investigated by feeding experiments. From the results of single and daily oral administration of cesium-134, it may be said that about 2 to 3 per cent of daily intake of radiocesium is transferred into egg, while yolk contains radiocesium of only $\frac{1}{5}$ to $\frac{1}{6}$ that in egg white. As urinary and fecal excretion of cesium is fairly rapid, about half the oral intake can be eliminated within a few days. (auth)

13431 THE EFFECT OF Na_3Ca-DTPA (PENTACENE) ON THE EXCRETION OF Pu^{239} FROM THE HUMAN ORGANISM. L. A. Plotnikova and G. D. Baisogolov. Med. Radiol., 9: 49-52(Jan. 1964). (In Russian)

Under observation were 5 persons who for a prolonged time worked in an experimental laboratory with different compounds of plutonium. Pentacene (1 g) in the form of a 10% solution for a course of 7 days was administered to all the persons examined. It was observed that pentacene exerts a favorable effect on the excretion of Pu^{239} from the human organism. (auth)

13432 TRANSITION OF RADIOISOTOPES FROM THE MOTHER TO RAT PROGENY. V. G. Kulikova. Med. Radiol., 9: 61-4(Jan. 1964). (In Russian)

In experiments conducted according to a unified technique, the transition of radioisotopes (P^{32}, Ca^{45}, Fe^{59}, Co^{60}, Zn^{65}, Rb^{86}, Sr^{90}, Y^{91}, Ru^{106}, I^{131}, Cs^{137}, Ce^{144}) from the maternal organism to the progeny of albino rats during the embryonic and postembryonic development was studied. The passage of different radioisotopes to the progeny through the placenta during pregnancy and with the milk during the lactation period depends upon the physicochemical properties of isotopes determining their place in the periodical system of elements. (auth)

13433 THE USE OF Y^{91} AS AN INERT INDICATOR IN INTESTINAL ABSORPTION TESTS. Jorge A. Maisterrena, Consuelo A. Murphy, Enrique Tovar, and Carlos Gitler (Hospital de Enfermedades de la Nutricion, Mexico City). Nucl. Med., 3: 356-67(1963).

The use of Y^{91} as an inert-indicator in the studies of the intestinal absorption of I^{131}-labeled substances is reported, emphasis being given to its clinical advantages. The Y^{91} is not absorbed in the gastrointestinal tract, since recovery in the feces in 22 cases was 96 ± 6.7% (S.D.) of the amount given. The Y^{91} and the I^{131}-labeled substances are homogeneously distributed throughout any given stool sample but their rate of excretion is not always parallel. A close correlation was found between the amount of I^{131} excreted as obtained from the complete fecal collection method and that of Y^{91}-indicator method in a group of 20 subjects under special supervision. The value of the Y^{91} inert-indicator method where the completeness of the stool collection is doubtful is shown in 23 cases. (auth)

13434 INTERPRETATION OF RADIONUCLIDE UPTAKE FROM AQUATIC ENVIRONMENTS. D. J. Nelson. Nucl. Safety, 5: No. 2, 196-8(Winter 1963-64).

Specific activities in aquatic organisms are useful in studies of radioisotope uptake. Factors and assumptions that must be considered in the use of specific activity data are outlined and discussed in connection with interpretation of radioisotope uptake data. (D.L.C.)

13435 THE ENTRY OF STRONTIUM-90 INTO HUMAN BONE. F. J. Bryant (United Kingdom Atomic Energy Authority, Woolwich, Eng.) and J. F. Loutit. Proc. Roy. Soc. (London), Ser. B, 159: 449-65(Feb. 18, 1964).

For 6 years human bones, mostly femora, were analyzed for strontium-90 by radiochemical methods and for natural strontium spectrographically. The mean concentrations relative to calcium (pc/g Ca and μg/g Ca) are charted according to age. In each year the peak value for Sr^{90} was in juveniles aged 1 to 2 years; it increased progressively in 1956–59 and fell in 1960–61. Values for the newborn which are dependent on maternal plasma and on domicile of mother moved similarly with time. By contrast, values for bones of adolescents and adults increased progressively. The concentration was substantially uniform between bones in infants and children. In adults cancellous bones, especially vertebrae, gave higher concentration than ivory bones. The mean values for stable strontium for the six-year period were ~200 μg/g Ca from birth until 6 months of age; they then rose sharply in the next year and later more slowly to 330 μg/g Ca in adults. It is deduced: that the discrimination between Ca and Sr across the human placenta is nearly twofold; that in the first year of the infant's life the discriminatory processes especially in absorption observed in the human adult are not fully developed; that by considering the specific activity (Sr^{90}/mg Sr) of bone in children according to cohort, bone turnover must be nearly complete in each of the first few years of life whereas in adolescents accretion of new salt is the preponderant factor; and that in the adult where growth has ceased the relative annual rates of replacement of existing mineral by new mineral from diet vary about 2% for ivory bone to 8% for vertebrae. (auth)

13436 STRONTIUM TURNOVER RATES IN HUMAN BONES. Joseph Rivera (Health and Safety Lab., AEC). Radiol. Health Data, 5: No. 2, 98-9(Feb. 1964).

Data are presented on the content of stable Sr in vertebra, rib, and femur from 12 accident victims of March, 1962. The content of Sr^{90} in the same samples was determined previously. On the basis of data on the Sr content of whole skeleton, the biological half life for Sr in the skeleton was calculated to be 11.6 yr. (C.H.)

13437 EFFECT OF SOME DRUGS ON THE EFFECTIVE HALF-LIFE OF THYROIDAL I^{131}. Kiyohiro Osari (Tohoku Univ., Sendai). Tohoku Igaku Zasshi, 65: 276-88 (Mar. 1, 1962). (In Japanese)

The influence of drugs on the retention of I^{131} by the thyroid was tested in human subjects (12 euthyroid cases and 16 cases of hyperthryoidism). After administration of desiccated thyroid, the effective half life (EHL) of thyroidal I^{131} was prolonged in the euthyroid subjects but unaffected in the hyperthyroid cases, except in one case after remission of the disease by I^{131} treatment, in whom administration of desiccated thyroid prolonged the EHL. After administration of KI, the EHL was prolonged in the euthyroid subjects and in the hyperthyroid cases given tracer doses of I^{131} but not in the hyperthyroid cases retreated with therapeutic doses of I^{131}. After administration of reserpine, the EHL was prolonged in all subjects, but inhibition of thyroidal I^{131} uptake was observed in none of them. These findings indicate that the release of hormone from the thyroid gland is under control of the hypothalamus. In hyperthyroidism it was confirmed that the control mechanism for regulating the hormone concentration in blood was disturbed. Reserpine raised the uptake of I^{131} by the thyroid gland, and this effect, in combination with its effect in alleviating hyperfunction of the thyroid, suggests that reserpine could be used for treatment of hyperthyroidism. (BBB)

13438 STUDIES OF THE INCORPORATION OF C^{14} IN MILK COMPONENTS AFTER INTRAVENOUS INJECTION OF 1-C^{14}-Na-ACETATE IN LACTATING GOATS. K. D. Sawatzki. Thesis, Hanover, Tieraerztliche Hochschule, 1962. 73p. $2.00(Gmelin, AED-DISS. 62-623).

The incorporation of C^{14} in the following milk constituents was studied: fatty acids, fats, casein, albumin, and lactose. All constituents reached the maximum of their activity 4 to 7 hr after injection. The highest concentration was observed in fat. The specific activity in lower fatty acids was higher then in higher fatty acids. The excretion in percent of C^{14} in milk fat was proportional to the total amount of fat. During the activity maximum 0.14% of the injected activity per g fat was found in the milk. (Gmelin Inst.)

13439 THE INCORPORATION OF Sr INTO THE YOLK OF HEN'S EGGS. J. Gropp. Thesis, Munich, Universität, Munich, 1962. 35p. $2.00(Gmelin, AED-DISS. 62-618). (In German)

Hens were given Sr carbonate for 180 days. After this period an equivalent amount of Ca carbonate was used. Sr and Ca in eggs were determined by means of a flame photometer. Sr was detected in yolk after 4 days. The Sr content increased to a constant value. After 180 days the Sr content of the skeleton decreased from 0.55% to 0.15%. (Gmelin Inst.)

Radiation Effects

Refer also to abstracts 13880 and 14132.

13440 (AD-401681) EARLY EFFECTS OF RENAL X-IRRADIATION. A. C. Corcoran (Saint Vincent Charity Hospital, Cleveland). 1962. Contract DA-49-193-2089. 15p.

Studies were made on the effects of heavy x irradiation on renal functions in dogs. Severe irradiation (2400–3000 r in 3 divided doses) of dog kidneys induced, even at the 3rd post-irradiation, a state of Na^+ and K^+ loss as compared to the normal kidney. This was followed, after some days, by impairment of water-reabsorbing capacity. The results indicated that angiotensin has a renal tubular as well as vasoconstrictor action. The vasculature of the irradiated kidneys develops increased vasoconstrictor responsiveness to angiotensin. It is suggested that the basic defect induced by irradiation soon after its administration lies at the basic cellular level of proton transfer and H^+ transport across cell membranes. (P.C.H.)

13441 (BL-85) PARTIAL CELL IRRADIATION AND SOFT X-RAY MICRODIFFRACTION. Progress Report. V. W. Burns and H. H. Pattee (Stanford Univ., Calif. Biophysics Lab.). Apr. 1963. Contract Nonr-225(51). 29p. (AD-404874)

The use of x-ray diffraction for the analysis of molecular structure and aggregation in biological materials is

reviewed. New techniques for soft x-ray microdiffraction are discussed. Design and operation of a soft x-ray microdiffraction source and camera are described. Applications of the microbeam equipment in studies of the effects of partial cell irradiation on cell division and morphology of the fresh water algae Micrasterias radiata are reported. (C.H.)

13442 (BNL-6935) AN ELECTRON MICROSCOPIC STUDY OF IN VIVO PRIMARY THROMBUS FORMATION. H. Cottier, B. Roos, E. P. Cronkite, and E. F. Luescher (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 36p.

Electron microscopic observations are reported for various stages of in vivo primary thrombus formation in the pituitary gland of rats during the first 24 hr after exposure of the head to a single dose of 8000 r x radiation. (48 references.) (C.H.)

13443 (BNL-6991) EFFECT OF IONIZING RADIATION ON MICROSPOROGENESIS IN PINUS RIGIDA MILL. F. Mergen and T. S. Johansen (Yale Univ., New Haven. School of Forestry and Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-1)-2755. 34p.

A cesium^{137} (9500 curies) source was placed in a natural pitch pine-oak forest at the Brookhaven National Laboratory. Beginning on November 22, 1961, the forest was exposed to gamma rays during 20 hours each day. Pinus rigida trees were exposed to radiation levels ranging from a high of 960 r/day to a level of normal background radiation. Microsporangiate strobili were collected and evaluated at regular intervals to follow the effects of gamma radiation on the cytology of microsporogenesis. In addition, mature pollen of Pinus rigida and Pinus strobus were exposed to acute γ radiation for a period of 16 hours from a cobalt^{60} source of approximately 3200 curies at levels ranging from 1 to 300 Kr. Trees receiving 82 r/day and higher were unable to resume cell division and differentiation during the spring of 1962, while microspore mother cells were formed on trees receiving 75 r/day. At 56 r/day meiosis with subsequent formation of tetrads took place, and the highest level at which viable microspores were collected was 11 r/day. A slight reduction in the length of the strobili was observed at 0.4 r/day, and at 3.7 r/day they were significantly shorter than the controls. The percentage of cells with visible chromosome aberrations increased with an increase in exposure: 0.4 r/day = 1%; 7 r/day = 2%; 11 r/day = 12%; and 17 r/day = 76%. Pollon abortion increased with an increase in radiation, and at 7 r/day, approximately 50% of the pollen grains were aborted. At 3 to 5 r/day, germination in vitro was reduced to 50% of the controls. Pollen tube length was not related to exposure. Mature pollen of Pinus rigida and Pinus strobus was able to grow normal pollen tubes in vitro after exposure to 300 Kr. Illustrations of the various observations are given, and the results are discussed in relation to physiological and genetic implications. (auth)

13444 (CU-1304-1) NUCLEIC ACID AND PROTEIN SYNTHESIS IN INDIVIDUAL CELLS AND CHROMOSOMES STUDIED BY RADIOACTIVE TRACERS AND AUTORADIOGRAPHS. Final Summary Report. J. Herbert Taylor (Columbia Univ., New York). 1964. Contract AT(30-1)-1304. 9p.

Plants, animals, and cell cultures were used to study: the time and mode of chromosome reproduction with particular reference to DNA snythesis; the mechanism of DNA replication; the primary function of chromosomes; the repair mechanism in chromosomes damaged by radiation or chemical agents; and the pattern and possible mechanism of chromosomal differentiation. Though a number of techniques were employed, high resolution autoradiography was the most useful. Results indicated that x-ray-induced aberrations and DNA synthesis occur simultaneously. Hence DNA synthesis was considered an indication that chromosome reproduction was occurring. Progress in attaining the objectives of the problem, much of which was previously published, is reviewed. (H.M.G.)

13445 (MMPP-196) EFFECTS OF MONOENERGETIC X-RAYS. [Period Covered]: June 15, 1962–February 28, 1963. G. Hoyt Whipple (Michigan. Univ., Ann Arbor. Michigan Memorial Phoenix Project). Mar. 1963. Contract AT(11-1)-1205. 22p. (ORA-5222-1-P)

Design features are described of a total-absorption x-ray calorimeter. A schematic diagram of the unit and gold absorber is included. Preliminary data are reported from measurements of x-ray effects on the activity of solutions of catalase and horseradish peroxidase. (C.H.)

13446 (NP-13640) PETITION FOR THE USE OF GAMMA RADIATION TO PROCESS WHEAT AND WHEAT PRODUCTS FOR THE CONTROL OF INSECT INFESTATION. L. E. Brownell, T. Horne, and W. J. Kretlow (Michigan. Univ., Ann Arbor and Curtiss-Wright Corp., Princeton, N. J.). July 1962. 162p.

Applications of γ radiation in the processing of wheat and wheat products for the control of insect infestation are discussed. Data are presented from studies of radiation dose necessary for insect control and the effect of these doses on the physical properties, nutritional value, and wholesomeness of wheat and wheat products. Results are summarized from feeding studies using rats and dogs. Methods are outlined for the radiation processing of wheat and wheat products, irradiation facilities are described, and an estimate on cost factors is included. (55 references.) (C.H.)

13447 (NYO-2315-1) RADIATION INDUCED VIABILITY MUTATIONS IN THE HONEY BEE. William R. Lee (New Hampshire. Univ., Durham). [1963]. Contract AT(30-1)-2315. 7p.

The frequency of recessive detrimental mutations expressed in the haploid drone honey bee was investigated and compared with recessive and dominant lethal mutations detected in the haploid drone and diploid worker. A single queen was inseminated by a drone homozygous for three genetic markers. Viability of progeny was determined, and hybrid daughters bearing the genetic markers were stored in colonies. The spermatheca of the queen was then irradiated with 2600 r kvp x rays. Morphological defects and viability were studied in progeny and grand-progeny. A total of 92 pairs was tested during one season. Results showed that 60.8% of the sperm cells receiving radiation contained at least one or more dominant lethals. Correcting for the saturation effect on the assumption of independence of each dominant lethal, an average proportion of 0.94 dominant lethals were found per cell. The average reduction in embryonic viability was 28%. Forty per cent of the queens tested contained one or more recessive lethals. Corrections in procedure and plans for future work, as well as work in progress, are described. (H.M.G.)

13448 (ORNL-TM-720) THE ORNL SPACE BIOLOGY PROGRAM ANNUAL REPORT, PERIOD ENDING JUNE 30, 1963. G. E. Stapleton and M. A. Bender (Oak Ridge National Lab., Tenn.). Nov. 8, 1963. Contract W-7405-eng-26. 39p.

Work performed from 1961 to July 1, 1963, in the ORNL Space Biology Program through an interagency agreement between the U.S. Atomic Energy Commission and the National Aeronautics and Space Administration is described.

The investigations are divided into a basic supporting program, which includes the ground-based laboratory research chiefly concerned with the relative biological effectiveness (RBE) of high-energy protons on a variety of biological materials ranging from bacteria to human blood cells, and a biosatellite program, which involves the development of testing methods and base-line radiation effects data on a number of biological materials for experiments in space vehicles in flight. The necessary equipment and instrumentation was developed for proton irradiations, and experiments were done with 22- and 130-Mev protons. The results of these experiments are reported. Plans for the future work with ground-based accelerators are discussed. The biological experiments flown in two of the NASA in-flight programs, the BIOS I space probe and the 1962 Goose Bay high-altitude balloon flights, are discussed. Experiments were designed for the NASA Biosatellite Program, and a limited number of feasibility tests were performed. These experiments are also discussed. (C.H.)

13449 (TID-20139) THE EFFECT OF X-RAYS IRRADIATION ON THE ACTIVITIES OF SOME LYSOSOMAL HYDROLASES OF HEART TISSUE. (International Atomic Energy Agency, Vienna). [1963]. 17p.

The effects of x radiation on lysomal hydrolases were studied by following changes in β-glucuronidase and β-galactosidase activities in irradiated mitochondrial suspensions of beef heart tissue lysosomes and heart tissue slices. No modification of these two enzymic activities was induced by radiation doses up to 440,000 r. (C.H.)

13450 (TID-20205) ATTEMPTS TO DELINEATE INBORN ANEMIAS IN MICE. Progress Report, February 1, 1963–January 31, 1964. Elizabeth S. Russell and Seldon E. Bernstein (Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.). Feb. 5, 1964. Contract AT(30-1)-1800. 22p.

Data are summarized from extensive investigations of the etiology of 4 different types of hereditary anemia in the house mouse, studies on mechanisms regulating hematopoiesis, and the effects of single-gene substitutions on the radiosensitivity of mice. (C.H.)

13451 (TID-20207) STUDY AND COMPARISON BETWEEN NECROLYTIC AND RADIOLYTIC LESIONS AT THE MITOCHONDRIAL LEVEL (LYSOSOMES) IN ASEPTICAL PERFUSED HEART MUSCLE. Final Report. (International Atomic Energy Agency, Vienna). [1963]. Contract IAEA 69/US. 43p.

The effects of x radiation on enzyme activity were studied in tissue homogenates and mitochondrial suspensions of beef heart muscle. Emphasis was placed on enzymes associated with lysosomes, or granules containing acid hydrolases with latent catalytic activity. Data are reported from studies on the properties of acid RNAse and DNAse in heart homogenates and mitochondrial suspensions before and after irradiation and the influence of enzymic degradation of beef heart lysosomal structures upon the release of some hydrolase activities. (C.H.)

13452 (TID-20219) THE BIOLOGIC EFFECTS OF RADIATION ON THYROID TISSUE. Annual Progress Report, September 15, 1961–September 14, 1962. Oliver Cope (Massachusetts. General Hospital, Boston). July 20, 1962. Contract AT(30-1)-667. 9p.

Data are summarized from a follow-up survey on patients who received RaI^{130} and I^{131} radiation therapy for hyperthyroidism since 1941. Emphasis was placed on possible carcinogenic action of radiation on the thyroid gland, the induction of leukemia, and genetic effects. Preliminary results are reported from a study of thyrotropic and radiation effects in thyroid diseases treated by radiotherapy. A routine assay was made of autopsied thyroid glands for radioactivity resulting from fallout I^{131}. A computer program was developed for use in the calculation of γ absorption in patients after the internal administration of radioisotopes. Preliminary studies using γ sources and a standard man phantom are reported. (C.H.)

13453 (TID-20220) INVESTIGATIONS ON MUTABILITY OF POLYGENES AND ON UTILIZATION OF INDUCED GENETIC VARIABILITY. Report of Scientific Activity Due After Completion of Three Years of Operation. R. E. Scossiroli (Pavia, Italy. Università. Istituto di Genetica). Dec. 31, 1963. Contract IAEA 61/US. 14p.

Observations on the R_1, R_3, and R_4 generations of maize from irradiated plants indicate an increase of genetic variability for most of the traits studied. The response to radiation was not proportional to dose in the 1500- to 3000-r range studied. A significant increase of genetic variation for many morphological as well as yield characteristics was found in tetraploid and hexaploid varieties of wheat grown from seeds exposed to doses of 10,000 to 20,000 r x radiation. The increase was more evident in the R_3 generation. Preliminary results are included from genetic studies in several varieties of wheat, tobacco, tomato, alfalfa, and Habrobracon after various x ray treatments. (C.H.)

13454 (TID-20223) RADIOBIOLOGICAL STUDY OF THE LYSOGENIC SYSTEM OF STAPHYLOCOCCUS ALBUS. Final Report. Luiz Renato Caldas (Brazil. Universidade, Rio de Janeiro. Instituto de Biofisica). [1962]. Contract IAEA 68/US. 4p.

Results are reported from a quantitative study of the effects of low γ-radiation doses on the lysogenic system of Staphylococcus albus. Results indicate that this is not a satisfactory system for use in studies of thresholds in radiobiology. Data are included from a study of the effects of streptomycin on S. albus. (C.H.)

13455 (TID-20231) ATTEMPTS TO DELINEATE INBORN ANEMIAS IN MICE. Nine-Year Comprehensive Progress Report, May 1, 1955–January 31, 1964. Elizabeth S. Russell and Seldon E. Bernstein (Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.). Feb. 5, 1964. Contract AT(30-1)-1800. 6p.

Hereditary anemias in mice were characterized for mutant alleles in six different series of mouse genes at developmental stages ranging from fetal to adult. The effects of transplanted normal isologous or homologous hematopoietic tissues on the hereditary anemias were investigated. Results are presented from studies on the effects of single genes on radiosensitivity of mice and tracer studies of metabolism in the hematopoietic tissues of anemic mice. (C.H.)

13456 (TID-20299) PARTIAL-BODY RADIATIONS OF QUEEN HONEY BEES. William R. Lee (New Hampshire. Univ., Durham). [nd]. Contract AT(30-1)-2315. 7p.

By shielding abdominal segments III through V queen honey bees survived otherwise lethal doses of x radiation. In contrast, irradiating only segments III through V with 10,000 r killed all queens within three weeks, as did whole-body irradiations. Lead shields that protect segments III through V and permit irradiating either the spermatozoa in the spermatheca or the oögonia of the ovary with higher doses than could otherwise be administered are described. (auth)

13457 (CEA-tr-X-491) EFFETS DE L'EXPOSITION DES TUBERCULES DE POMMES DE TERRE AUX RAYONS GAMMA, SUR LES PLANTES DE PREMIERE ET DE SECONDE GENERATION. (Effects of Exposure of Potato Tu-

bers to Gamma Rays on the Plants of the First and Second Generation). A. Benvenuti. Translated into French from Agr. Ital. (Pisa), 62: No. 3, 75-93(1962). 31p. (Includes original, 10p.).

The preliminary results of the study of the biological and morphological effects of gamma radiation (2500, 5000, and 7500 r) on plants of the first and second generation are reported. The effects of the irradiation on the germination rhythm, growth characteristics, seed, foliage, and fruiting are given in tabular form and are discussed. The same plant characteristics were studied for the second generation plants. (J.S.R.)

13458 (JPRS-22915) THE NATURE OF MICRONECROTIC FOCI OF HEMOPOIETIC ORGANS OF ANIMALS EXPOSED TO RADIATION. M. N. Meysel' and V. M. Manteyfel'. Translated from Izv. Akad. Nauk SSSR, Ser. Biol., No. 6, 871-8(1963). 12p. (OTS-64-21398)

Luminescent microscopy in both the visible and ultraviolet range was found to be a convenient method for studying phagocytosis and other intracellular activities. A method is described for the preparation of tissue samples for luminescent microscopy. Application of the method in studies of radiation effects at the cellular level in hematopoietic tissues of rats is described. (C.H.)

13459 (JPRS-23224) PROBLEMS OF BIOGEOCHEMISTRY IN RADIATION HYGIENE. V. V. Koval'skii (Koval'skiy), V. I. Baranov, and V. E. (Ye.) Sinel'nikov. Translated from Gigiena i Sanit., 28: No. 12, 81-6(1963). 9p. (OTS-64-21557)

The consequences of the continuous increase in radiation background level due to nuclear explosions and waste from atomic energy industries are postulated for future generations. It is pointed out that laboratory studies on animals do not furnish adequate data on long-term effects of radiation and that animal data cannot be extrapolated to man. It is suggested that studies on genetic and somatic changes in human populations exposed for many generations to high levels of natural radioactivity would provide valuable data. The creation of a new science called biogeochemistry is reported. This is the branch of geochemistry and biology that is concerned with the study of the role of organisms in the migration of chemical elements in the environment and the determination of the effect of these elements on the adaptive chemical and morphological variability of plants, animals, and man. Areas with excessive or insufficient natural chemical content or radioactive substances are defined as biogeochemical provinces. It is proposed that biogeochemical provinces with high uranium content in the soil and high Ra content in drinking water be defined and used for studies of geochemical ecology. (C.H.)

13460 (JPRS-23507) NATURAL RADIOMIMETIC AND ITS EFFECT ON VARIOUS BIOLOGICAL OBJECTS AND SYSTEMS. Yu. B. Kudryashov, G. I. Gasanov, E. N. Goncharenko, V. B. Dorozhinskii, P. G. Dryanovskii, M. L. Kakushkina, A. G. Konoplyanikov, N. G. Labzina, and Yu-hua Hsueh. Translated from Zh. Obshch. Biol., 25: 3-16 (Jan./Feb. 1964). 20p. (OTS-64-21708)

A natural radiomimetic substance was isolated from the liver of irradiated rabbits. Chemical assay showed that the substance contained oxidation products of unsaturated fatty acids. The substance produced effects similar to those induced by radiation in rats, mice, erythrocytes, yeast, ascites carcinomas, and mitochondria. The possibility of the participation of the substance in primary reactions of radiation injury is discussed. Protection against the action of the radiomimetic substance was provided by AET and cysteamine. (C.H.)

13461 (JPRS-23559(Del.)) PATHOLOGY, PATHOLOGICAL PHYSIOLOGY AND EXPERIMENTAL THERAPY. Translated from Arkh. Patol., No. 12, 44-56(1963) and Patol. Fiziol. i Eksperim. Terapiya, [7]: No. 6, 72(1963). 19p. (OTS-64-21729(Del.))

Pathology of radioisotopes is considered, and radiation sickness therapy is discussed. Four papers are presented. Separate abstracts were prepared for three. (H.M.G.)

For abstracts of individual papers see: 13462, 13463, and 13564.

13462 (JPRS-23559(Del.)(p.28-35)) THE MORPHOLOGY OF MAMMARY GLAND TUMORS INDUCED WITH RADIOACTIVE NIOBIUM. V. I. Ponomar'kov. Translated from Arkh. Patol., No. 12, 44-50(1963).

White female rats were given Nb^{95} abdominal cavity injections at doses of 6 μC/g of body weight. Animals were sacrificed upon discovery of tumors. Tumors began to appear 164 days after administration of the isotope and developed in 38% of the survivors. In control rats mammary tumors, occurring in about 10%, first appeared on the 487th day following commencement of observation. The morphological structure of the tumors was distinguished by great diversity: adenocarcinomas with different extent of tissue differentiation, adenomas with different ratio of stroma and parenchyma, sarcomas of immature structure, and also fibrosocystosic mastopathies. Ranking first in frequency of different types of neoplasms were adenomas (56.5%), adenocarcinomas (23.9%), and sarcomas (2.2%). Mastopathies were found in 17.4% of cases. (auth)

13463 (JPRS-23559(Del.)(p.36-42)) THE CONDITION OF SENSITIVE INNERVATION OF THE NOSE AND TONGUE OF DOGS DURING AFFECTION WITH RADIOACTIVE STRONTIUM AND POLONIUM. B. I. Lebedev. Translated from Arkh. Patol., No. 12, 51-6(1963).

At different stages of acute and chronic radiation disease induced by Sr^{90} or Po^{210}, changes in the nerve conductors and receptor apparatus of the mucosa of the tongue and nose, and the skin of the nose prove to be largely reversible in dogs. At initial periods of the development of the disease the end sensory apparatuses are changed more profoundly than the neurons of the corresponding nerve ganglia. At the peak of acute radiation sickness and at remote periods of chronic radiation sickness changes in the neuron bodies proved to be more pronounced than those of their processes and endings. The nerve formations investigated were unevenly affected. Focalness of changes was found to hold in all structures. Earlier and later changes were observed in the region of the preterminals of nerve conductors. Disorders in the sensory structures investigated when Po^{210} was administered gradually increased and became significant. When Sr^{90} was given the changes were less pronounced, and the development of the pathological process was wave-like in nature. (auth)

13464 (OTS-63-11011) SELECTED ARTICLES ON THE USE OF IONIZING RADIATION IN POTATO STORAGE AND DISEASE PROBLEMS. Translated from Russian IPST Cat. Nos. 707 and 712. 1963. 79p.

Separate abstracts were prepared on two sections of this report. (C.H.)

For abstracts of individual sections see: 13465 and 13466.

13465 (OTS-63-11011(p.1-75)) THE USE OF IONIZING RADIATION TO CONTROL THE DORMANCY OF POTATO TUBERS DURING STORAGE. B. A. Rubin, L. V. Metlitskii, E. G. Sal'kova, E. N. Mukhin, N. P. Korabelva, and N. P. Morozova. Translated from Biokhim. Plodov i

Ovoshchei, Akad. Nauk SSSR, Inst. Biokhim., 5: 5-101 (1959).

Results of extensive studies on the radiation processing of potatoes led to the conclusion that γ irradiation will prevent tuber sprouting for one year without impairing resistance to spoilage microörganisms. The physiological condition of the tubers and radiation dose rate were found to be important factors. Data are included from studies on the effects of various doses and dose rates on sprouting of various varieties of potatoes, changes in the chemical composition of irradiated potato tubers, the effects of γ radiation on oxidation-reduction processes and nucleic acid metabolism in potato tubers, the effects of irradiation on the resistance of potatoes to microörganisms that induce spoilage, and an investigation of optimal conditions for the storage of irradiated potatoes. (113 references.) (C.H.)

13466 (OTS-63-11011(p.76-9)) THE ACTION OF IONIZING RADIATION ON THE RESISTANCE OF POTATO TUBERS TO FUNGI (FUSARIUM sp.). E. N. Mukhin. Translated from Dokl. Vses. Akad. Sel'skokhoz. Nauk, [24]: No. 9, 14-17(1959).

Fungi of the Fusarium genus cause dry rot of potatoes and are responsible for much of the loss of stored potato tubers. The fungi are unable to penetrate the protective tissues of the tuber and enter only through damaged surfaces. Results are reported from a study of the effects of γ radiation on damaged tuber tissues. Reactions of potato tubers to trauma included suberin formation on the wound surface, formation of a wound periderm, peroxidase activity, and the synthesis of ascorbic acid. Irradiated potatoes were found to be more sensitive to Fusarium infection than controls, even when no wound periderm had formed. Tubers irradiated with 5,000 r γ radiation were less susceptible to infection than tubers irradiated with 10,000 r. (C.H.)

13467 EXPERIMENTAL INVESTIGATIONS IN MURINE HEPATITIS. IV. THE EVOLUTION OF MHV_2- AND MHV_4-INDUCED HEPATITIS IN THE ADULT WHITE MOUSE EXPOSED TO THE ACTION OF X RAYS. O. Burducea, G. Popescu, C. Baba, and V. Negula (Institutul de Inframicrobiologie al Academiei P.R.R., Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Inframicrobiol., 13: 251-54(1962). (In Rumanian)

It has been shown previously that after x irradiation of adult mice, naturally resistant to infection by Coxsackie virus, they become susceptible to its pathogenic action, as seen by a significant difference in mortality of irradiated and nonirradiated animals. The purpose of the investigation was to study the effect of x rays on the susceptibility of the adult mouse to the pathogenic action of murine hepatitis virus MHV_2 and MHV_4. The animals received a total whole-body irradiation dose of 600 r given over 17 min. They were then inoculated intraperitoneally with 0.2 ml of a virulent suspension of 10 LD_{50} of either virus. The animals were observed for eight days to study the incubation period, mortality rate, and histopathologic changes in mice, and compare them with the controls. Results showed that mortality was consistently 100% for the virus-infected, irradiated mice compared with only 50% for the virus-infected, nonirradiated control mice. The same results were obtained with both virus strains. Irradiation also affected the incubation period, shortening it to 2.2 and 2.8 days from 6.0 and 5.3 days for MHV_2 and MHV_4 respectively. There was no appreciable difference between test and control mice in the characteristic lesions of murine hepatitis in liver sections observed microscopically. As the same effects have been observed with other viruses, Coxsackie and influenza, it was concluded that irradiation brings about certain, as yet undefined, changes in the exposed animals, which are favorable to the development of virus infection. (BBB)

13468 DIFFERENT PLOIDIES OBSERVED IN THE ROOT TIP MERISTEM OF PROGENIES OBTAINED BY GAMMA IRRADIATION (Co-60) OF PEA FLOWER BUDS. E. Kurnik, B. I. Pozsar, and J. Parragh (Agricultural Experimental Inst., Iregszemcse, Hungary). Acta Botan. Acad. Sci. Hung., 9: 67-74(1963).

A pea variety (IP-1) was irradiated with a 20-kr dose in the initial phase of microsporogenesis. In seeds developed from the flower buds of peas irradiated about the time of meiosis, individuals of different ploidy were found by cytological examination of root tips. Chromosomes with three satellites were encountered in the chromosome set of the irradiated variety. Seven of 384 cytologically analyzed individuals were polyploid, which, apart from being a comparatively high number, is of theoretical significance on account of the observed difference in the degree of ploidy. In peas, polyploidy induced by γ irradiation is noteworthy because polyploid individuals could not be produced either by colchicine or by use of other mutagenic agents. Compared to other ploidy types, triploidy induced in meiosis by irradiation occurs frequently. The conditions for the production of triploid peas are probably analogous to those previously studied in connection with the triploidy of sunflowers. The anomaly described in the second maturity division of microsporogenesis probably leads to the genesis of pollen with diploid generative nucleus which, if fertilized, results in tripolidy. While triploidy induced by irradiation is about 4% in the sunflower, it is 0.5% in peas. While only triploidy was observed in the sunflower, five other types of ploidy, with an approximate frequency of 1.3%, were found in the pea. Besides tetraploid, also hexaploid, nonaploid, decaploid, and dodecaploid chromosome sets were encountered. The occurrence of individuals of another than the triploid type was less frequent. Only the triploid and tetraploid individuals could be raised to the flower or mature seeds stage and then reproduced. Individuals of abnormal ploidity (nonaploid, decaploid, dodecaploid) died at the onset of vegetative development. It is suggested that polyploidy may be traced to structural changes in spindle fibers. (BBB)

13469 THE DIRECT ANTIGLOBULIN CONSUMPTION TEST AFTER RADIOTHERAPY AND CHEMOTHERAPY. E. Robinson and D. Nelken (Rothschild Hadassah Univ. Hospital, Jerusalem). Acta Haematol., 30: 138-43(1963).

To investigate the origin of hematologic changes resulting from radiotherapy, the direct antiglobulin consumption test was performed in 37 patients before and after radiotherapy (and chemotherapy, to see whether the changes after chemotherapy are similar to those appearing after local radiotherapy). The patients received local tumor doses of up to 5000 rad of x radiation. In the 28 patients given radiotherapy, the consumption test became positive or more strongly positive in 17; there was no change in 4; and it became weaker in 7 patients. In the 9 patients who received chemotherapy with cytostatic agents, all tests that were negative before treatment became positive after treatment, and those that were positive before treatment became strongly so. Nine patients received 10 to 15 mg Meticorten daily, either together with, or subsequent

to, irradiation or chemotherapy treatment. This did not influence the result of the test. In most patients there was a drop in white blood count, but there was no correlation between the white cell drops and the change in the consumption test. When the test was repeated after an interval without further treatment, tests that had become positive after treatment became less so or negative. Of the 11 patients whose test showed no change or its degree of positivity became reduced, 8 had received radiotherapy to the upper abdomen and left hemithorax. In no patient who received treatment to these areas did the consumption test become stronger, a phenomenon that could not be explained, and animal experiments are being undertaken to elucidate this problem. The area of treatment, size of field and the dose, seemed to have an influence upon the result of the test, as shown by an analysis of individual cases. This test is more sensitive than the usual tests for the detection of antibodies in the serum and this accounts for the high percentage of positive results. Whether the coating globulin causing the positive test is an antibody or a globulin attached to a damaged blood cell is not yet settled. The finding of a positive or more strongly positive test after radiologic or chemotherapeutic treatment supports the second possibility. The positive test in a patient who has not had any previous treatment may be due to some globulins produced by the tumor itself. The mere coating of the cells with these globulins may interfere with cell metabolism and shorten its life. (BBB)

13470 EFFECT OF NITROGEN MUSTARD POISONING AND TOTAL-BODY X-RAY IRRADIATION ON THE GLYCOGEN LEVEL OF THE LIVER. D. Tanka and G. David (National Inst. of Rheumatology and Balneology, Budapest). Acta Morphol. Acad. Sci. Hung., Suppl. 10: 66(1962).

Rats were irradiated with 800 r, a dose equal to the $LD_{50/30}$. A second group of animals was treated with nitrogen mustard in a dose equivalent to $LD_{50/30}$. In formalin-fixed livers periodic acid-Schiff (PAS) reaction showed the glycogen to have disappeared in 24 to 48 hr. Restitution sometimes took 30 days. Simultaneously a series of alcohol-fixed livers was studied histochemically. The glycogen content was seen to decrease in 48 hr with subsequent restitution generally taking 240 hr. The biochemical changes paralleled the histochemical pattern in alcohol-fixed livers. To explain these observations it is suggested that the glycogen molecules in the liver, when exposed to the effect of radiation or nitrogen mustard, become less polymerized and thus more water-soluble. Proof of this was furnished by ultracentrifugal molecular weight determination of the glycogen extracted from the livers of the irradiated or nitrogen mustard-poisoned animals. When the liver glycogen specimens were grouped according to the degree of PAS positivity, and the samples with identical glycogen content were pooled and subjected to ultracentrifugation, the results supported this hypothesis. (BBB)

13471 SOME ASPECTS OF SYNERGISTIC ACTIONS OF HALOGENOPHENOLS ON RADIATION LETHAL EFFECT. Mitsuo Namiki, Akira Matsuyama, Yoshishige Okazawa, and Ichiro Kaneko (Inst. of Physical and Chemical Research, Tokyo). Agr. Biol. Chem. (Tokyo), 27: 358-64(May 1963).

Data concerning the synergistic action of halogenophenols in increasing the radiation lethal effect on Escherichia coli are presented. The synergistic action of the agents was greatly depressed by the addition of certain organic materials or freezing during irradiation. The organic materials, considered to scavenge free radicals, were investigated to determine whether an indirect action of ionizing radiations is involved in the enhancement of the radiolethality. Synergistic actions of halogenophenols irradiated with L-cysteine (0.0005M) or peptone (1%) were largely abolished. These results suggest that indirect actions of ionizing radiations may play an important role in the halogenophenol action. After-effects of the irradiated agents were also observed and the magnitude of significance of the after-effect appeared to vary with differences in chemical structures of halogenophenols. It is postulated that their synergistic effects during irradiation may be due to the actions of short-lived free radicals produced by the radiolysis of halogenophenol and also to some radiation damage within cells. The persistent after-effect of halogenophenols irradiated in aqueous solution is interpreted as the result of formation of toxic long-lived species or molecular products by radiation. Since such after-effects could be observed more or less with every irradiated halogenophenol solution, inactivation caused by these long-lived species may be operative in the synergistic action of halogenophenols during irradiation to increase the radiolethality. The after-effect seemed to be increased at higher temperatures in comparison with that at lower temperatures (below 10°C). Increasing temperatures up to 60°C during irradiation also intensified the induction of bactericidal activity in the irradiated solutions. This suggests that induction of the bactericidal activity by irradiation may not be a simple process, but involve reactions stimulated by heating. (BBB)

13472 HEPATIC LESIONS PRODUCED BY IRRADIATION OF THE ANIMAL IN HIBERNATION. HISTOLOGICAL AND HISTOCHEMICAL STUDY. A. Cavina Pratesi and C. Vassalo (Université, [Pavia, Italy]). Ann. Radiol., 6: R906-17(1963). (In French)

A comparative study was made of histological and histochemical changes in the liver of porcupines irradiated with varying doses during the waking state and during natural hibernation. There was a considerable decrease in the number of lesions in animals irradiated during hibernation. This phenomenon was interpreted in terms of current radiobiological knowledge. (auth)

13473 SARCOMA FOLLOWING IRRADIATED RETINOBLASTOMA: REPORT OF A CASE. Renato Frezzotti and Roberto Guerra (Ospedale Santa Maria della Scala, Siena, Italy). Arch. Ophthalmol., 70: 471-3(Oct. 1963).

The case is reported of a one-yr-old child who received x-ray treatments for bilateral retinoblastoma and developed a fibrosarcoma in the irradiated area 4 yr later. At the age of one yr the more severely involved left eye was enucleated. The tumor did not appear to have extended beyond the eye; however, the orbit was irradiated through two portals, direct and temporal, for a total of 3000 r in air (~2000 r on the orbital walls). Six months later, the same treatment was repeated. The enucleated bulb showed the characteristic features of a retinoblastoma of the neuroepitheliomatous type. Although the tumor involved ~⅔ of the fundus, the right eye was treated by irradiation according to the Martin-Reese technique; the treatment was given daily during 46 days, for a total of 4200 r tumor dose. The tumor receded slowly but completely. No cataract developed, but small fibrous cords, containing Ca masses, were present in the vitreous. At the age of 5 yr a second neoplasm arose in the left nasal passageway and ethmoid. The interval between irradiation and the apparent onset of the second tumor was ~4 yr, and histologic specimens showed the characteristic features of a mesodermal

(fibrosarcoma) and not a metaplastic retinoblastoma. The development of postirradiation sarcoma in tissues that have been exposed to heavy doses of x ray, is an uncommon but well-established sequel in the treatment of retinoblastoma. In spite of the occurrence of secondary tumors, it is suggested that x-ray treatment of the better eye according to the recently modified Martin-Reese method, combined with enucleation and irradiation on the opposite side, is still the treatment of choice for bilateral retinoblastomas so long as some vision is present. (BBB)

13474 INVESTIGATIONS ON THE INFLUENCE OF X-RAYS ON THE NERVUS ISCHIADICUS OF THE FROG IN DEPENDENCE ON IRRITATION FREQUENCY, ON IRRITATION VOLTAGE, ON THE PREVIOUSLY RECEIVED DOSE, AND ON THE DOSE DISTANCE IN THE CASE OF FRACTIONATED IRRADIATION. Kurt Vanselow (Universität, Kiel). Atomkernenergie, 9: 68-72(Jan.-Feb. 1964). (In German)

The influence of x rays on the electric parameters of the nervus ischiadicus of the frog was investigated systematically. The peak potential of all nerve fibers of the bundle served as criterion. Potential changes during irradiation in proportion to the stimulation potential, to the stimulation frequency, to the number of already given irradiations and, thus, the previously received total dosage with single irradiations, to the difference of two irradiations with double irradiations, and to the spot of irradiation on the nerve were investigated. The nerve was irradiated at the spot at which it was stimulated in all investigation series but one. The nerve signal was taken from a not-irradiated spot for the first investigation. (auth)

13475 DAMAGE TO HUMAN CELLS BY VARIOUS SORTS OF IONIZING RADIATION. [PART] I. G. W. Barendsen. Atoomenergie Haar Toepassingen, 5: 251-8 (Dec. 1963). (In Dutch)

After a description of the principles and purposes of a study on radiation damage to human cells, the various radiation sources used and the techniques for the culture of the human cells are considered in some detail. An indication is given of the relative biological effectiveness of the different types of radiation. (tr-auth)

13476 DAMAGE TO HUMAN CELLS BY VARIOUS TYPES OF IONIZING RADIATION. PART 2. G. W. Barendsen. Atoomenergie Haar Toepassingen, 6: 1-7 (Jan. 1964). (In Dutch)

The interpretation of the dose-effect relationship of various types of radiation is given. The effect of administering the radiation in fractions and the effect of the cellular medium on the radiation damage are described. (tr-auth)

13477 ON THE DARKREACTIVATION MECHANISM IN ULTRAVIOLET IRRADIATED BACTERIA. Karl Metzger (Universitat, Cologne). Biochem. Biophys. Res. Commun., 15: 101-9(Mar. 9, 1964).

Four strains of Escherichia coli, one of which was arginine and adenine deficient, were grown to a titer of 4×10^8 in M-9 medium supplemented with arginine and adenine. Cells were washed and resuspended in M-9 without adenine, adenine-starved for one hour, and irradiated with a low pressure mercury lamp emitting predominantly 2537 Å wavelengths. After irradiation the bacteria were plated on caffeine agar directly or incubated at 37° without adenine and plated at 60, 120, 180, 240, or 300 min postirradiation. Similarly, another set of samples was adenine-starved prior to irradiation. Both irradiated and unirradiated controls were plated on tryptone agar without caffeine. The experiments demonstrated that: hostcellreactivation (HCR) and darkreactivation (DR) are achieved by the same enzyme; DR directly repairs uv lesions; photoreactivation (PhR) and DR repair the same lesions in nucleic acids; the enzyme is neither induced by phage infection nor by uv irradiation, but is normally present in the bacterial cell; and the action of the enzyme is inhibited by caffeine. (H.M.G.)

13478 WITH IONIZING RADIATION IRRADIATION OF CONDENSED PHASE. J. Bednář (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Řež). Collection Czech. Chem. Commun., 29: 88-96(Jan. 1964). (In German)

A qualitative description of a condensed substance under the influence of ionizing radiation is given, touching on the assumption that the absorbed energy in the initial stages is "delocalized" in an essentially larger volume than that of a single molecule. The energy for short times was localized as the duration of the vibration of the medium and also caused the formation of super-excited states of the medium, since it was sometimes deposited in the primary mutual exchange in higher amounts than the ionization energy of the medium amounted to. Some parameters are mentioned, the knowledge of which should make possible the exact description of a liquid- or solid-phase irradiated substance. (tr-auth)

13479 BIOLOGICAL HALF-LIFE OF L-THYROXINE AND OF 3,5,3′-TRIIODO-L-THYRONINE-I^{131} IN THE RAT EXPOSED TO WHOLE-BODY X IRRADIATION OF A FATAL DOSE. M. Lemaire and J. Closon (Université, Liege). Compt. Rend. Soc. Biol., 157: 1513-18(1963). (In French)

The gradual growth of L-thyroxine (T_4) and 3,5,3′-triiodo-L-thyronine (T_3), labeled with I^{131} in the 3,5′ and 3′ positions, respectively, was comparatively studied in the normal rat and in rats exposed to whole-body lethal doses of x radiation five days before the subcutaneous injection of T_4 and T_3. The irradiation does not significantly modify the biological half life of I^{131}. In addition, there is no incidence of the dehalogenation of the two hormones. These conclusions are valid both for the injection of a physiological dose (0.05 μg/100 g) and a pharmacological dose (100 μg/100 g). The fecal radioactive excretion is slightly increased in the irradiated animals, but this increase appears significant only in the rats receiving a pharmacological dose of T_4. (tr-auth)

13480 EFFECT OF X RAYS ON THE FERTILITY OF YOUNG RATS IRRADIATED 8 OR 17 DAYS AFTER BIRTH. A. Léonard and J. R. Maisin (Centre d'Etude de l'Energie Nucléaire, Mol, France). Compt. Rend. Soc. Biol., 157: 1529-33(1963). (In French)

Preliminary results obtained in a study of the reproductive capacity and the further fertility of young male and female rats irradiated at the age of 8 or 17 days are reported. Female rats irradiated 8 days after birth have a much lower fertility as adults than rats irradiated at the age of 17 days. This difference in radiosensitivity is much less evident in the case of male rats. AET has an evident protective effect on the fertility of both male and female rats, regardless of the age at the moment of irradiation and the dose used (50, 150, 300, or 500 r). (J.S.R.)

13481 EFFECT OF IONIZING RADIATIONS ON THE SYNTHESIS OF ATP BY ERYTHROCYTES. Bernard Magnan de Bornier and Nicole Bensaid (Faculté de Médecine, Montpellier, France). Compt. Rend. Soc. Biol., 157: 1658-61(1963). (In French)

The effect of ionizing radiation on the synthesis of ATP by erythrocytes was investigated on suspensions of human erythrocytes. After exposure, centrifugation, and resuspension in plasma of the erythrocytes, adenosine is added to the suspension. The suspensions are incubated, and the ATP concentration is determined as a function of the incubation time. The results are tabulated for x-ray doses of 10,000, 18,000, and 30,000 r. They show that the synthesis of ATP is reduced by irradiation. The synthesis decreases progressively with increasing radiation according to a sigmoid curve with the inflexion point at 11,000 r. (J.S.R.)

13482 THE EFFECT OF X-RAY IRRADIATION ON THE CELLS OF EHRLICH'S ASCITIC CARCINOMA AS INVESTIGATED BY RADIOAUTOGRAPHY. O. S. Frankfurt and L. P. Lipchina (Inst. of Chemical Physics, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 154: 207-9(Jan. 1, 1964). (In Russian)

A total of 1×10^7 cells of Ehrlich's ascitic carcinoma was administered intraperitoneally to mice of the BALB line. Three days later the mice were subjected to a whole body, x-ray dose of 800 r. Thymidine labeled with tritium (TH^3 with a specific activity of 3 curies/mmol) was introduced intraperitoneally at a dose of 5 μC. Smears of ascitic liquid were taken each day on three mice, and radioautographs were prepared in order to determine the uptake of thymidine by the cell as compared to the control. The results show that the transition of the premitotic phase to mitosis ($G_2 \rightarrow M$ transition) is blocked for a period of 10 hours after the irradiation. Then, all the cells undergo a single division, and blocking of the G_2 phase again takes place. The irradiation had only a slight effect on the synthesis of DNA. The net effects of the irradiation are that cell multiplication is arrested for about one day, and that the distribution of the cell population in various phases changes after the irradiation. These after-effects are of significance in the treatment of cancer of radiotherapy or chemical reagents. (TTT)

13483 THE YIELD OF BIOCHEMICAL MUTATION REVERSALS IN YEAST AS A FUNCTION OF THE PLOIDY ON INTERACTION WITH VARIOUS KINDS OF RADIATION. I. P. Arman and S. N. Ardashnikov. (Kurchatov Inst. of Atomic Energy, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 154: 212-15(1964). (In Russian)

Previous research on the survival of yeast cells showed that haploid yeast cells are the most sensitive to radiation, and diploid yeasts are the most resistant to radiation. In most cases, a microorganism that cannot grow on a medium lacking some essential ingredient carries a point mutation, and can revert to its initial wild state. It would be expected that with the same irradiation dose, the mutation reversal would have twice the frequency in the homozygous diploid mutant than in the haploid mutant. To test this hypothesis, haploid and diploid yeast cells were irradiated with Co^{60} γ rays and ultraviolet radiation. The results showed that the number of mutation reversals in the haploid strains increased more rapidly than in the corresponding isogenous diploid strains with increasing radiation dose. The behavior was similar for the two types of radiation. The increased frequency of mutation reversals of haploid cells as compared to diploid cells with the same irradiation dose can be partially explained, if it is assumed that a number of sites in the gene have been modified and can act as suppressors. This type of suppressor is recessive. (TTT)

13484 REVIEW OF RESEARCH ON USE OF RADIATION-INDUCED MUTATIONS IN CROP BREEDING IN JAPAN. Takane Matsuo and Hikoyuki Yamaguchi (Tokyo Univ.). Euphytica, 11: 245-55(Oct. 1962).

Radiation treatment has been used to improve the grain yield, stiffness of straw, earliness, disease resistance, seed quality, and other agronomic characters. In wheat and tobacco, radiation has been utilized for transmitting disease-resistant genes from wild species to cultivated ones by means of chromosomal translocations. Radiophosphorus (P^{32}) and x rays were used in earlier studies on rice, the most intensively investigated plant in Japan, while later experiments have also employed γ radiation (from Co^{60} and Cs^{137}) neutrons, and S^{35}. Among the characters that have been observed as mutated in rice, chlorophyll deficiency, heading time, culm length, and grain weight are most easily obtained. Some of the induced mutants showed the same or higher productivity as compared to the parent variety. A table is provided showing the principle irradiation variants obtained in Japan, and lists the kind of plant, the irradiated component, period of radiation and dosages applied, changes induced, and where experiments were conducted. General conclusion of interest in radiation botany, gained from these investigations, are summarized. The most effective doses for mutation breeding are estimated for dry seed treatment in various crop plants as ranging from 20 to 60 r of x or γ radiation. Effect of moisture content, protective chemicals, and other external factors on radiosensitivity of seeds is discussed. Fractional x irradiation of rice seeds produces more sterility than single irradiation, and increase of the test period elapsing between the first irradiation and the next gives more sterile panicles. The frequency of chlorophyll mutation shows no difference between fractional dosages and single ones. Maximum frequency of chlorophyll mutation in rice is higher for thermal neutrons than for x rays, but the relative frequency of various kinds of chlorophyll mutations produced by x rays and thermal neutrons seems to be similar. From experiments using rice seeds, the 1-r equivalent effects produced by thermal neutrons were calculated. For fast neutron irradiation of rice seeds, it is estimated that approximately 6×10^6 n/cm^2 are equivalent to 1 r from x radiation for the production of chlorophyll mutation. Treatment of rice seeds with P^{32} results in a very high frequency of morphologic mutations, 2 to 3 times higher than that with x rays, in terms of the mutation frequency per X_1 plant. The mutagenic effects of 0.2 mC/g P^{32} and 0.8 mC/g I^{131} solutions correspond roughly to those of 2.5 kr γ radiation in experiments using dormant seeds of Einkorn wheat. Repeated irradiation of rice seeds in successive generations is more effective than single irradiation. Screening techniques for selection of mutants are discussed. In general the pedigree method of screening X_1 spike (or panicle) strains has been used; however, it has been proposed that bulk handling of X_2 progenies using one seed from each X_1 individual might be more efficient for screening mutants. The majority of mutations in cereals are those concerned with chlorophyll production. Earliness or lateness of heading time of radioinduced mutant strains in rice as compared to the parent variety is mainly attributable to the decrease or the increase of photoperiodic sensibility, and is connected with the minimum heading duration. The earliness of mutant strains in rice may be ascribed to the recessive mutation of a single independent gene. Some accompanying changes of morphologic or physiologic characters in these early strains are also attributable to the recessive mutation of one gene which is independent of the genes related to heading time. It is concluded that although methods of plant breeding utilizing ionizing radiation have

not been perfected yet, radiations readily induce mutants which prove useful in crop improvement. (BBB)

13485 PATHOLOGIC ANATOMICAL CHANGES IN THE THYROID GLAND AFTER TREATMENT WITH RADIOACTIVE IODINE. Sven Hernberg and Per Fortelius (Maria Hospital, Helsinki). Finska Lakaresallskapets Handl., 105: 133-46(1961). (In Swedish)

Gross and microscopic pathological findings in the thyroid glands of 12 patients treated with 8- to 40-mC doses of I^{131} are described. Eleven of these cases were being treated for thyrotoxicosis and nodular goiter and one case for adenocarcinoma of the thyroid. At the time of death, seven patients had become euthyroid, and three died before the I^{131} treatment had become effective; two patients were hypothyroid. In three cases, no radioactivity could be detected in the thyroid gland at autopsy. In four cases, severe degeneration of epithelial cells and Huerthle cells with bizarre chromatin figures were noted. Nuclear pyknosis was usually present, and the gland was fibrotic in five cases. Microfollicular structures were apparent in eight cases, and I^{131} treatment was also responsible for hyperemia, follicular rupture, and bleeding into the follicles in two cases. Blood vessel changes were not severe, but in a few cases the occurrence of teleangiectasia, capillary dilatation, and medial arterial necrosis was noted. Although focal collections of lymphocytes were present in two cases, Hashimoto's disease was not evident in any case. In none of the 11 thyrotoxicosis patients treated with I^{131} were malignant changes in the thyroid apparent. Previous studies in this field are reviewed and the results compared with the present findings. The marked tendency for nodule formation in endemic goiter in Finland is discussed. (BBB)

13486 BLOOD COAGULATION, PLASMA PROTEINS, AND HEMATOLOGIC CHANGES IN SUBJECTS CHRONICALLY EXPOSED TO X RAYS. A. Mungo, G. Chiariello, and P. Piccoli (Università, Naples). Folia Med. (Naples), 45: 1214-26(Dec. 1962). (In Italian)

Changes in blood clotting were evaluated by thromboelastography and clotting factor tests, and plasma protein levels and hematologic values were studied in 13 men and 2 women occupationally exposed to 100- to 120-kv x rays in a radiology department. In all individuals there was a prolonged clotting time, with a tendency toward increase in the Howell time and a dimunition in the Quick time. Thromboelastography showed an increase in time for formation of first fibrin filament in five cases; increase in time for clot formation was noted in eight cases. In some instances there was a deficiency of Factor V and Factor VII, and lower blood prothrombin level. Study of hematologic values indicated a marked platelet deficiency in almost all cases. Slight anemia and leukopenia, accompanied by lymphocytosis, were also noted. Electrophoretic studies of plasma proteins gave normal values. The accumulated exposure to repeated small doses of radiation produces chronic irreversible changes in many clotting factors. Changes in blood coagulatability are ascribed mainly to injurious actions of x rays on megakaryocytes leading to deficiency of platelets and subsequent hemostatic impairment. (BBB)

13487 HAZARDS OF RADIATION INJURY IN RELATION TO RULES FOR MEDICAL INDICATIONS FOR INTERRUPTION OF PREGNANCY. J. H. Mueller (Universität, Zurich). Geburtsh. Frauenheilk., 23: 847-51(Sept. 1963). (In German)

The possible necessity of therapeutic abortion following diagnostic or therapeutic radiologic procedures in women during the first trimester of pregnancy is discussed, with emphasis on the minimal fetal dose for recommendation of abortion. A discussion by nine participants is presented. It is concluded that radioinduced genetic injury of the mother is not sufficient reason for abortion, but that such intervention may be necessary if a fetal dose of 10 r is exceeded during the first two months of pregnancy. At later stages of pregnancy the acceptable dose does not exceed 25 r. However, radiodiagnostic procedures in the last trimester of pregnancy are not considered a hazard to the fetus. The importance of avoiding any radiation exposure of women during the last half of the menstrual cycle is emphasized. Some dosimetric data are presented showing the fetal-body, fetal-gonad, and maternal-gonad doses received during various abdominal radiologic procedures and with x rays of different kilovoltages. (BBB)

13488 THE FREQUENCY OF INTESTINAL STENOSIS AFTER IRRADIATION OF GYNECOLOGIC CARCINOMAS WITH CONVENTIONAL AND ULTRAHARD X RADIATION. F. Oberheuser (Universität, Hamburg). Geburtsh. Frauenheilk., 23: 1032(Nov. 1963). (In German)

In 130 out of 2120 patients, treated between 1950 and 1962 for primary gynecologic cancer, rectal-vaginal fistulas or intestinal stenosis, as a result of radioinduced necrosis or fibrosis, were observed. Stenosing fibrosis of the intestine after treatment of cancer of the uterine body or cervix with additional Ra implantation was seen in nine cases. Most of the cases (73%) were treated for cervical cancer, and intestinal stenosis was most frequent in this group. The frequency of this complication, occurring within 1 yr of irradiation of the cervical cancer group, was 2.7% after conventional and 1.7% after supervoltage radiotherapy. (BBB)

13489 GENETIC EFFECTS OF GAMMA-IRRADIATION ON EGG PRODUCTION AND ADULT EMERGENCE OF DROSOPHILA MELANOGASTER. R. W. Touchberry and J. C. DeFries (Univ. of Illinois, Urbana). Genetics, 49: 387-400(Mar. 1964).

Newly emerged male and female flies from one inbred and one randombred population were subjected to 0, 500, 1000, or 1500 r of gamma-radiation and then mated in all possible combinations within populations, resulting in a four × four factorial arrangement of treatments. Daily egg production over a ten-day period was determined from two replicated experiments for the treated flies, their untreated progeny (Generation 1) and grand-progeny (Generation 2). Generation 2 resulted from full-sib matings of members of Generation 1. Eggs laid each day which resulted in viable adults were determined for Generations 1, 2, and 3 (Generation 3 resulting from two generations of full-sib mating). Mean daily egg production was not significantly affected by irradiating males or females with 1500 r or less of gamma rays; however irradiation of the female parent with 2000 r or more of x rays had a marked depressing effect on egg production. Irradiation of the male parent did not affect egg production appreciably. The partial linear and quadratic regression coefficients of daily egg production on day of oviposition for each pair of flies indicated no significant differences associated with levels of irradiation of males or females. Large linear depressing effects associated with irradiation of both male and female parents were found in Generation 1 for mean daily percent adult emergence. Treatment of the females had no appreciable effect on the percent of eggs deposited by their progeny or grand-progeny which resulted in viable adults; however, treatment of the males had a significant effect

on descendants. The weighted partial linear and quadratic regression coefficients of percent adult emergence on day of oviposition were determined for each pair of flies. Analyses of the differences of these coefficients indicated that secondary spermatocytes and early spermatids were more sensitive to radiation induced genetic damage than were spermatozoa, later spermatids, primary spermatocytes, and spermatogonia. Less differential effect was found for irradiation of females than males. Nevertheless, gametes treated as primary oöcytes were more susceptible to damage than those treated as oögonia. Irradiation of male Drosophila resulted in four to five times as much genetic damage in the gametes as did irradiation of the female. Evidence of this greater damage is also present in the gametes produced by the progeny and grand-progeny of irradiated males, the extent of the damage being approximately halved each generation. (auth)

13490 EFFECT ON GENETIC DAMAGE OF POST-TREATMENTS GIVEN X-RAYED DROSOPHILA MALES. James E. Trosko (Michigan State Univ., East Lansing). Genetics, 49: 401-9(Mar. 1964).

An increase in sex-linked lethal mutation rate after cold storage of irradiated sperm was noted when nonirradiated females were starved prior and subsequent to mating. Cold and aging during the storage of the irradiated sperm did not, per se, contribute to the increase of sex-linked lethals. At the same time, these data supplement the findings of others that no change in radiation-induced damage to sperm occurs when the irradiated sperm are or are not stored in the female. The evidence from postirradiation storage of the male at room temperature and at 10°C does not support a hypothesis for a recovery mechanism occurring in the sperm. The rates of sex-linked lethals and of egg mortality, associated with the first sperm batch, decreased after 24 hours postirradiation storage of the males at room temperature. The rates of the second sperm batch (sperm used 48 hours after irradiation) of the latter males did not exhibit a decrease as might be expected if a recovery process exists. Furthermore, postirradiation storage of the males at 10°C did not modify the rates of sex-linked lethal mutation or egg mortality. The data are interpreted to indicate that the population of sperm at the time of irradiation is heterogeneous and compartmentalized with respect to radiation sensitivity, and that mixing of these sperm can occur in the testes during postirradiation storage at room temperature. (auth)

13491 THE FORMATION OF DUMPY VORTICES IN MOSAICS OF DROSOPHILA MELANOGASTER. Jack Lester King (Univ. of California, Berkeley). Genetics, 49: 425-38(Mar. 1964).

Certain alleles of the gene dp produce vortices, which are changes in the configuration of the dorsal surface of the thorax and in the distribution of thoracic chaetae and hairs. The dp alleles appear to affect the chaeta pattern through tissue movement, since they do not change the total number of bristle organs. Cellular changes which occur are bristle organs with doubled chaetae, and small "bald" areas devoid of chaetae and cell hairs. The vortices are associated with insertions of certain of the indirect flight muscles through deep invaginations of the hypodermis and cuticle. Vortex formation begins prior to normal attachment of the flight muscles: the formation of vortices is indirectly responsible for the development of doubled chaetae. X-ray induced somatic crossing over produced mosaic patches which were homozygous for dp and homozygous or hemizygous for yellow on a heterozygous wild-type background. Thirteen mosaics, including eight involving recessive lethal alleles, were recovered from an estimated 7,000 treated individuals. In the mosaic specimens, the dumpy recessives are nonautonomous: homozygous recessive patches bring about the vortex pattern in the adjacent heterozygous or homozygous dominant tissue, and, in three cases, in the heterozygous tissue of the opposite side of the thorax. The doubling of chaetae in the vortices is an indirect effect, since it sometimes occurs in the background tissue. The wild-type allele of dp, in response to specific developmental environments, appears to regulate (either directly or by intracellular inhibition) the production of a supracellular factor, which in turn affects tissue movement. The recessive alleles apparently fail to respond to these developmental environments, leading to a failure to regulate the production of the supracellular factor and thus to abnormal tissue movement. It is concluded that dp is not a prepattern gene with respect to the distribution of thoracic bristle organs, since it does not have any effect on the determination of bristle organ anlagen. The differentiation of doubled chaeate, however, is due to a physical change in the cellular environment, indirectly brought about by dp; in this minor respect dp can be considered a prepattern gene. (auth)

13492 X-Y NONDISJUNCTION AND EXCHANGE INDUCED BY X RAYS IN PRIMARY SPERMATOCYTES OF THE ADULT DROSOPHILA. S. Zimmering and C. K. Wu (Brown Univ., Providence). Genetics, 49: 499-504 (Mar. 1964).

X-irradiation of primary spermatocytes of adult yv/B^sYy^+ Drosophila melanogaster males was demonstrated to produce a greater proportion of X-Y exchanges than X-Y nondisjunction. This result is consistent with the previous findings of Zimmering and Wu (1963) following irradiation of the prepupal testis, but is disagreement with those reported by Slvhagen (1961) and by Strangio (1961, 1962) from experiments on adult males. (auth)

13493 POPULATION SIZE AND GENETIC LOAD IN IRRADIATED POPULATIONS OF DROSOPHILA MELANOGASTER. Hampton L. Carson (Washington Univ., St. Louis). Genetics, 49: 521-8(Mar. 1964).

Two experimental populations of the sepia-spineless-rough stock of Drosophila melanogaster each received 65,000 r of x rays over a period of $2\frac{1}{2}$ years. Two control populations were handled in an identical manner but received no radiation. All four populations were discarded one year after the cessation of irradiation of the experimentals. The method of handling permitted weekly measurements of population size of all populations, affording a measure of fitness of the populations. As expected, the size of the experimental populations declines under radiation. Population size is recovered rapidly when radiation is suspended. Although one of the experimental populations maintained an elevated fitness level at several times for a number of generations, these effects were reversed and at the end of the experiment, controls and experimentals did not differ from one another. Following the cessation of the irradiation, the genetic loads of the irradiated populations were found to be elevated relative to the controls. These increased loads, however, disappeared within a year. Newly induced mutations do not appear to provide an important source of genetic diversity whereby fitness can be improved in experimental population systems where natural selection is operating. (auth)

13494 RADIOBIOLOGICAL STUDIES IN PLANTS. VI. EFFECTS OF RADIATIONS FROM THE NUCLEAR REACTOR, JRR-1, ON DRY SEEDS OF WHEATS AND

OATS. Ichizo Nishiyama, Sadao Ichikawa, and Takeo Maruyama (Kyoto Univ.). Ikushugaku Zasshi, 12: 237-45(1962).

Dry seeds of Triticum monococcum, T. dicoccum, T. persicum, T. vulgare, Aegilops squarrosa, Avena strigosa, A. barbata, and A. sativa were irradiated in the beam of the Japan Research Reactor No. 1 (JRR-1). The radiations were mainly thermal neutrons, with contaminating resonance neutrons, fast neutrons, and γ rays. Seed germination was not affected by a dose of 9.2×10^{11}n (th)/cm^2 or 1.8×10^{12}n(res)/cm^2, but was clearly disturbed by 9.2×10^{12}n(th)/cm^2, excepting hexaploid species. Seedling heights of diploid species were decreased distinctly by 1.8×10^{12}n(res)/cm^2 and extremely by 9.2×10^{12}n(th)/cm^2 doses, but tetra- and hexaploid species were more tolerant than diploids. Moreover, the experiments indicated that Avena is generally more resistant than Triticum. Both length and width of the first, second, and third leaf blades were reduced by certain dosages, the first leaf being most resistant and the third most sensitive. This suggests that leaves in different developmental stages show different responses to radiation. The LD_{50} for thermal neutrons, x rays, and γ rays were determined for each species. By comparison of the survival rate 100 days after sowing, a dose of about 2.1×10^8n(th)/cm^2 of thermal neutrons (plus other contaminating radiations) in JRR-1 was calculated to have the effect equivalent to 1 r of x or γ rays. (BBB)

13495 EFFECT OF γ-RADIATION UPON SUSCEPTIBILITY OF POTATO TUBERS TO PHYTOPATHOGENIC MICROORGANISMS. E. N. Mukhin and E. G. Salkova (Inst. of Biochemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol., No. 1, 137-42(Jan.-Feb. 1964). (In Russian)

It was found that susceptibility of irradiated potatoes to infectious diseases increases in proportion to the dose of the ionizing radiation and is also dependent on the presence of mechanical injuries in the tubers. The reduction of the wound reactions as manifested in the suppression of the capacity to form wound periderm at the sites of mechanical injury only increases infection susceptibility of the irradiated tubers. The major causes of reduced potato resistance are however the disturbances elicited by irradiation in various links of metabolism that reduce the response of the tissues to the infection. Changes in carbohydrate metabolism were revealed as well as in respiration and in the water retaining capacity of cell colloids of the irradiated tubers. To reduce the adverse effect of radiation upon the resistance of tubers these should be of highest initial quality and gamma rays should be used in as small doses as possible. (auth)

13496 ASSESSMENT OF RADIATION DAMAGE BY MEANS OF PERIPHERAL BLOOD CULTURES. Dorothy L. Weijer, H. E. Duggan, and J. Weijer (Univ. of Alberta Hospital, Edmonton, Can.). J. Can. Assoc. Radiologists, 14: 60-6(June 1963).

Experiments are described in which the use of parameters, such as the incidence of pyknotic leukocytes and the incidence of binucleate cells, are investigated from the point of view of their utility in assessment of low-level radiation damage in peripheral leukocyte cultures. Sufficient P^{32} and S^{35} were incorporated into cultures to give doses of 50, 100, and 200 rad, over a culture period of 72, 96, and 120 hr. Human white cell cultures were irradiated also with 300-kv x rays at a dose rate of 4 r/sec (dose: 12.5, 25, 50, and 100 r), and at regular intervals (72, 80, and 96 hr) cultures were stained and examined for pyknotic leukocytes and binucleate cells. A burst of mitotic activity occurred in all cultures between 65 hr (in controls) and 72 hr in cultures treated with 100 r, 100, and 200-rad P^{32} or S^{35}. There was no significant difference in the incidence of binucleate cells in 72- and 96-hr cultures following x irradiation (50 and 100 r) and the frequency of binucleate cells arising in S^{35}-supplemented cultures (50 and 100 rad) at 72 and 96 hr of incubation. However, in P^{32}-treated cultures (P^{32}, unlike S^{35}, is incorporated into the cell), the number of binucleates was several times that found in cultures treated with an equal dose of S^{35} and incubated for the same time. Radioisotope incorporation assays showed that the cellular uptake of P^{32} after 94 hr of incubation was 4% of the added isotope, whereas no S^{35} was incorporated by the cells during the same period. The frequency of pyknotic cells in x-irradiated leukocyte cultures was correlated with dose and culture time. An increase in the dose by a factor of four gives rise to an increase in the number of pyknotic cells by a factor of approximately 2 at equal culture times. Cultures treated with S^{35} (50 and 100 rad) yielded approximately equal amounts of pyknotic cells per 100 viable leukocytes as did the x-irradiated cultures (50 and 100 r) at equal culture times. Although x irradiation took only a few minutes, whereas the irradiation from S^{35} took place over the entire culture period, a similarity existed between the pyknotic index at various dose levels in both cases. It is concluded that a correlation exists between the number of aberrant forms, increasing radiation dosage, and increasing culture time. Results with x ray and S^{35} are comparable, but P^{32} gives an enhancing effect owing to its incorporation and subsequent transmutation in vital cellular components, especially DNA. (BBB)

13497 THE USE OF X RAYS AS THE UNCONDITIONED STIMULUS IN FIVE-HUNDRED-DAY-OLD RATS. James C. Smith and Dale D. Morris (Florida State Univ., Gainesville). J. Comp. Physiol. Psychol., 56: 746-7(Aug. 1963).

Attempts were made to resolve conflicting reports on the threshold dose for the unconditioned stimulus (US) of ionizing radiation as an aversion to saccharin. Earlier studies employed both the simultaneous presentation of conditioned stimulus (CS) and US and the trace conditioning technique, and although some investigators have been unable to demonstrate the conditioned aversion with doses lower than 200 r, others were able to show it with total doses as low as 10 r of γ radiation over a wide variety of dose rates. These investigations, however, were limited to animals ranging in age from 60 to 120 days. Since effects of x irradiation on rats have been shown to be a function of age, the present study was undertaken in an attempt to condition an aversion to saccharin fluid with x rays as the US in rats older than those used in previous studies. In addition, the strength of the saccharin aversion was studied as a function of both dose and amount of saccharin fluid (CS) ingested prior to irradiation. Male Wistar rats, 500 days old, were whole-body irradiated with 50- to 350-r doses of 250-kv x rays at 30 r/min, and control rats were sham-irradiated. On the day of irradiation, 0.1% saccharin fluid was offered the animals. Twenty-four hr after irradiation, two bottles were attached to each cage, one containing tap water and the other containing saccharin fluid. At the end of a 48-hr preference test the bottles were removed and the total fluid consumption and the S score were determined. The S score is equal to the proportion of the total fluid consumption that was saccharin. There was no significant difference between the S scores or total fluid intake for the 6 irradiated groups (50, 100, 150, 200, 300, 350 r). Although the deprivation conditions gave rise to significantly different consumption of saccharin fluid presented as a CS, the deprivation condi-

tion has no apparent effect on the amount of fluid intake or the S score for a postirradiation test. When the groups are reconstituted on the basis of the amount of saccharin fluid consumed in the CS, again no effect is noted on the two postirradiation measures. The threshold for the conditioned aversion was between 0 and 50 r and an increase in the roentgen dose up to 350 r had no effect. Conditioned aversion can be obtained as readily with mature animals as with young animals. The threshold for this effect is close to that found earlier in 60- to 120-day-old rats (~10 r). (BBB)

13498 EFFECTS OF GAMMA RADIATION ON MATING COMPETITIVENESS AND BEHAVIOR OF DROSOPHILA MELANOGASTER MALES. T. J. Henneberry and W. L. McGovern (U. S. Dept. Agriculture, Beltsville, Md.). J. Econ. Entomol., 56: 739-40(Dec. 1963).

To determine whether radiation affected the mating behavior, an irradiated or untreated male fly was introduced into a vial containing a single virgin female. All treated male flies were three to four days old when exposed to 8 or 16 kr of γ radiation from a Co^{60} source delivering about 320 r/min. Untreated males or males exposed to 8 kr showed no difference in courtship time during their first or second matings, either on the same day of treatment or on the day after treatment. Males exposed to 16 kr were slower to mate the first and second times on the day of treatment. However, 24 hr after treatment, males treated with 16 kr had recovered and mated as readily as untreated males or males exposed to 8 kr. The time in copulation was also unaffected by irradiation. Males exposed to 16 kr, when confined with 5 or 10 virgin females, mated fewer times than untreated males during the first 24 hr. Irradiated males confined with 20 virgin females mated less frequently than untreated males confined with 20 virgin females but not less than untreated males confined with 5 or 10 virgin females. However, at the end of three days the irradiated flies confined with 5, 10, or 20 virgin females had mated as many times as untreated males. Thus the delay in number of matings by males irradiated at 16 kr corresponds to the delay in the courtship period recorded in the 1st experiment. The effect of irradiation on competitiveness of males irradiated with 16 kr was determined by confining for a 24-hr period these males and untreated males in 1:1, 5:1, 10:1, and 20:1 ratios with 10 virgin females. At all ratios, except the 5:1, treated males were as competitive as untreated males. (BBB)

13499 THE RESPONSE OF X-IRRADIATED LIMBS OF ADULT URODELES TO NORMAL TISSUE GRAFTS. I. EFFECTS OF AUTOGRAFTS OF SIXTY-DAY FOREARM REGENERATES. Benjamin D. Stinson (Cornell Univ., New York). J. Exptl. Zool., 153: 37-52(June 1963).

Results are reported of autoplastic transplantation of parts of nonirradiated, regenerated forelimb to the contralateral x-irradiated forelimb in adult Triturus viridescens. The right forelimbs were exposed to various doses of localized irradiation (1000 to 5000 r) followed by amputation of both left and right forelimbs through the mid forearm. Left limbs regenerated normally, but irradiated right limbs failed to exhibit any significant degree of regenerative activity over a 3-month period. Both forelimbs were reamputated through the distal humerus and observed for an additional two months. Left limbs produced normal regenerates, but irradiated right limbs gave no gross evidence of regeneration at any of the radiation dose levels. Normal left regenerates were reamputated immediately distal to the elbow on the 60th day after the second amputation; the severed forearm was trimmed with scissors along anterior and posterior borders and denuded of skin over its proximal half, leaving an essentially complete forearm region as a normal autograft. This was implanted into the irradiated right upper arm stump, after ablation of the distal half of its humerus, with normal proximodistal polarity in all cases. The irradiated stump was reamputated through the distal portion of the implanted normal autograft two weeks after implantation, and was observed for four months. Periodic gross observations showed that over 90% of irradiated upper arms formed regenerates at a rate which paralleled that of nonirradiated controls. However, regenerates formed on irradiated upper arms exhibited a restriction of morphogenetic capacity, only 60% attaining 3- and 4-digit stages. Most of the morphologically more complex regenerates which developed on the irradiated upper arm stumps manifested left limb asymmetry despite their formation on right irradiated stumps, suggesting a relation between the asymmetry of the normal graft and that of the resulting regenerate. All regenerates which developed on irradiated upper arms showed marked deficiencies in the restoration of a complete proximodistal structural pattern appropriate to the level of amputation through the irradiated stump. However, the actual pattern produced was appropriate to the level of amputation through the implanted normal autograft. These findings support the hypothesis that normal grafts promote the formation of regenerates on irradiated limbs through the autonomous developmental activity of the transected graft. (BBB)

13500 SEX AS A FACTOR IN DELAYED-RESPONSE AND REDUCED-CUE DISCRIMINATION LEARNING BY PREVIOUSLY IRRADIATED MONKEYS. A. A. McDowell, W. Lynn Brown, and A. C. McTee (Univ. of Texas, Austin). J. Genet. Psychol., 100: 325-9(June 1962).

Earlier study showed female rhesus monkeys to be superior to males on spatial delayed-response learning performance. The superiority of the female monkeys was attributed to their greater attentiveness, as experimentally demonstrated, rather than to a sex difference in intellectual ability. The present study was conducted to determine whether similar sex differences were present in an independent group of monkeys that had previously been exposed to a nuclear radiation. Delayed-response and reduced-cue discrimination tasks were used to test 56 rhesus (Macaca mulatta) monkeys, ranging in age from 30 to 42 months, which had been exposed to a nuclear radiation at the Nevada Test Site approximately 14 months earlier. The estimated total dose varied from 273 to 670 rem (γ plus neutron radiation). Training was conducted in a modified version of the Wisconsin General Test Apparatus. The females improved performance significantly faster than did the males on reduced-cue discrimination learning. Performance of the females on delayed-response training was significantly superior to that of males, although rate of improvement with practice did not differentiate the sexes. Hence, these findings confirm the superiority of female rhesus monkeys over male rhesus monkeys on spatial delayed-response performance. The results also show a difference of a similar nature on reduced-cue discrimination performance, a task incorporating elements of both object quality discrimination and delayed-response problems. These results provide added evidence for the need to evaluate the sex factor before generalization of the results of any learning study involving monkeys of both sexes. (BBB)

13501 EFFECTS OF REPETITIOUS WORK ON PERFORMANCE OF NORMAL AND FOCAL-HEAD IRRADIATED MONKEYS. A. A. McDowell and W. Lynn Brown (Univ. of Texas, Austin). J. Genet. Psychol., 103: 305-8(Dec. 1963).

It was previously found that under repetitious work conditions a significantly larger proportion of control than of whole-body irradiated monkeys manifested balking and that significantly more balks were shown by balking control than by balking irradiated monkeys. The present study was conducted to determine whether focal-head irradiated male rhesus monkeys differ from normal monkeys in a manner analogous to whole-body irradiated monkeys under repetitious work conditions. Five normal monkeys, four with previous focal-head irradiation (2 doses of 3000 r 30 days apart) of the posterior association areas, and one monkey with previous focal-head irradiation of the frontal association areas, were tested for 50 trials or until balking occurred each day for 44 days on a single form-discrimination problem. If any monkey refused to respond within a 3-min time limit at any point in the daily testing, he was accorded a balk for that day. The results showed that subjects of the three goups differed significantly with respect to frequency of balking, the control group showing the fewest balks and the monkeys with previous focal-head irradiation of the frontal association areas the most balks. Thus, focal-head irradiated monkeys differ from normal monkeys in a converse manner from whole-body irradiated monkeys under conditions of repetitious work. Such data demonstrate lasting effects of focal-head irradiation with x rays, and also suggest sites of permanent damage for monkeys given sublethal whole-body radiation exposure other than those of the restricted areas of exposure in the present study. The present findings also indicate that balking under conditions of repetitious work reflects something other than frustration induced by problem difficulty. Balking occurred significantly later in training than did the achievement of a rigid criterion of learning. (BBB)

13502 SOCIAL DISTRACTIBILITY OF NORMAL AND PREVIOUSLY IRRADIATED MALE RHESUS MONKEYS. A. A. McDowell and W. Lynn Brown (Univ. of Texas, Austin). J. Genet. Psychol., 103: 309-16(Dec. 1963).

A study was made of the effects of distraction upon free-cage behavior to determine the relation between amount of previous whole-body radiation exposure of adult male rhesus monkeys and behavioral stability under conditions of social distraction. The irradiated monkeys had been exposed to atomic weapons detonations 3½ years earlier at various doses of radiation, from 10-rep neutron plus 70-r neutron radiation to 54-rep + 554-r doses. Other monkeys were chronically exposed 6 years earlier in the lab to doses up to 670 rem. Exposed monkeys were each systematically observed once, over a 3-day period, under each of three conditions of social distraction. One condition had no social stimuli present, a second had an adult female monkey at menses present, and the third had an adult female monkey at estimated time of ovulation present. Order of condition presentation was counterbalanced over days within each radiation-dosage group. The female monkey was, in each instance, visually, but not physically accessible, being placed in a cage three feet from the cage housing the experimental male monkey. The study was repeated one month later with the same experimental subjects. Statistical treatment of each set of data yielded a significant radiation groups-by-conditions interaction. Each interaction reflected a positive relation between amount of previous whole-body radiation exposure and behavioral stability under conditions of social distraction. These results are interpreted as reflecting decreased social distractibility accruing to whole-body radiation exposure and are in accord with findings of previous studies concerned with the effects of nonsocial distractions upon performance of specific laboratory tasks. Whether these results reflect direct effects of radiation exposure upon the endocrine system of the monkey remains to be determined. (BBB)

13503 SOME EVIDENCE OF PSYCHIC BLINDNESS IN MONKEYS WITH FOCAL-HEAD IRRADIATION OF THE TEMPORAL LOBES. A. A. McDowell and W. Lynn Brown (Univ. of Texas, Austin). J. Genet. Psychol., 103: 317-23(Dec. 1963).

This study was conducted to compare the effects of various extra-cage social stimuli on the free-cage behavior of normal monkeys and of monkeys with previous focal-head irradiation. Four control and four focal-head irradiated monkeys with nearly identical training histories were used, the latter being the survivors of a focal-head irradiation study conducted 4½ yr earlier. They had received 3000 r x radiation to an area of the head containing the inferior parietal lobule and posterior aspect of the temporal lobe, and repeated 30 days later. Each group was systematically observed under each of four social-stimulus conditions with the order of condition presentation counterbalanced within each group over a 4-day period. The four social-stimulus conditions included: absence of social stimulus, an adult male monkey, an adult female monkey at menses, and an adult female monkey at estimated time of ovulation. The social-stimulus conditions showed no effect on the nondirected activities of the normal monkeys, but produced a marked decrease in the nondirected activities of the focal-head irradiated monkeys, with the least number of such activities being manifest in the presence of the adult female monkey at ovulation. Under conditions of social stimulation the normal monkeys showed a marked decrease in total directed activities of the non-social-stimulus condition, while the focal-head irradiated monkeys showed a marked increase, the effect in each instance being greatest in the presence of the female at ovulation. The directed activities, toward the cage as an object, of the controls decreased and those of the experimental subjects increased. The controls were more than twice as responsive to the female at estimated time of ovulation as to the other two social stimuli, while the experimental monkeys were equally responsive to each of the three social stimuli. The data suggest the presence of psychic blindness in the monkeys previously exposed to focal-head irradiation of the temporal lobes. (BBB)

13504 HEAT AND GAMMA-RADIATION RESISTANCE OF BACILLUS MEGATERIUM SPORES. A. Tallentire and C. O. Chiori (Univ. of Manchester, Eng.). J. Pharm. Pharmacol., 15: 148T-9T(Dec. 1963).

The correlation between heat resistance and resistance to ionizing radiation was studied in spores of Bacillus megaterium. Spores grown in a chemically defined medium and suspended in sterile water were heated in a 100° bath for different periods. Exponential time/survival curves (survivors estimated from colony counts) were constructed and the slopes of these used as a measure of heat resistance. Modification of the medium gave spores with different resistances to heat. Similarly, slopes of exponential dose/survival curves were used as a measure of spore resistance to cobalt-60 gamma rays. Results confirm earlier reports that high resistance of spores to heat is dependent on the divalent metallic ion content of the sporulation medium. However, radioresistance was un-

changed by the variations in the divalent metallic ion content of the medium. Low heat resistant spores produced by the technique were far more heat resistant than corresponding vegetative cells. Therefore, it is suggested that possibly the same mechanism responsible for this disparity is a common regulatory mechanism for the usual high resistance of spores to both heat and radiation. (H.M.G.)

13505 A DEPENDENCE ON WATER CONTENT OF BACTERICIDAL EFFICIENCY OF GAMMA-RADIATION. A. Tallentire, N. A. Dickinson, and J. H. Collett (Univ. of Manchester, Eng.). J. Pharm. Pharmacol., 15: 180T-1T (Dec. 1963).

Gamma irradiation of Bacillus megaterium spore samples of different water content was carried out at 22° in the absence of oxygen. To avoid lethal damage from postirradiation oxygen effect, all samples were given an anoxic postirradiation soaking with liquid water. Surviving fractions based on colony counts gave exponential dose/survival curves that were used as a measure of radiation lethal efficiency. The equilibrium water vapor pressure range tested was from 5×10^{-4} to 21 torr. In changing from a condition in which spores are driest to one in which they are in equilibrium with water vapor at a partial pressure equivalent to 100 percent relative humidity, the lethal efficiency of the gamma radiation increases by about 35 percent. (H.M.G.)

13506 THE SUSCEPTIBILITY OF THE EFFECTS OF WHOLE-BODY IRRADIATION ON THE DIENCEPHALON–HYPOPHYSIS SYSTEM OF THE RAT TO CYSTEINE. Ulrich Heckmann, Horst Kleinert, and Hans A. Kuenkel (Universitäts-Frauenklinik und Strahlenbiologisches, Hamburg and Universität, Hamburg). Naturwissenschaften, 50: 732-3(1963). (In German)

The effect of cysteine on the radioinduced release of neurosecretion by the posterior lobe was investigated. Rats were exposed to a whole-body dose of 1000-r x radiation and sacrificed three days later. The Gomori positive granula concentration was quantitatively evaluated on the frontal layer through the hypophysis-posterior lobe region. The results for controls, animals receiving 1000 r, animals receiving 1000 r + cysteine, and animals receiving cysteine only were tabulated. A significant protective effect of cysteine was noted. The distribution of the Gomori positive granula showed typical changes after irradiation that were modified by the preliminary administration of cysteine. (J.S.R.)

13507 EVOLUTION OF ENZYMIC DNA-SYNTHESIZING ACTIVITY IN SOME ORGANS OF THE RAT FOLLOWING X IRRADIATION. Monique Jacob, Pierre Chambon, and Paul Mandel (Faculté de Medecine, Strasbourg). J. Physiol. (Paris), 53: 373-4(1961). (In French)

Variations in DNA polymerase activity were studied, using P^{32} incorporation techniques, in spleen, thymus, and testes of rats following whole-body x irradiation with 700-r doses. There was no significant difference in tissue deoxyribonuclease activity between control and test animals. Results which compared DNA contents in various tissues showed that in the spleen there was a moderate decrease in polymerase (25 and 42%, 12 hr and 2 days postirradiation). Although DNA content continued to decrease and then remained at a level 20 to 30% of the initial values, polymerase activity increased 57 and 114%, respectively, four and seven days postirradiation. These results were different from values for specific activity of DNA labeled with P^{32} in vivo, an index of DNA synthesis intensity. DNA specific activity was reduced 55, 70, and 50% respectively after 12 hr, 2, and 4 days. At 7 days, specific activity values were normal. Thus there was a greater reduction of DNA synthesis and recovery took longer. It appears, assuming this polymerase to be responsible for DNA synthesis, that the enzyme's sensitivity to x rays is not the only cause of the retardation of synthesis. In the thymus there was a greater reduction of polymerase activity than in spleen. Reductions in thymus were 61, 79, 67, and 35% respectively 12 hr, 2, 4, and 7 days following irradiation. In this instance also, the return to full activity of the enzyme preceded the reappearance of DNA. Activity of the enzyme in the testes followed a different pattern. Thus, it did not vary during the first two days; on the fourth day a small decrease of 20% was observed, which was followed by a reduction of tissue DNA. It was concluded that DNA polymerase is not directly or primarily sensitive to x rays. Although a certain parallel was shown to exist between its variation and the rate of DNA synthesis, DNA biosynthesis appears to be more influenced by other factors in the irradiated cell. (BBB)

13508 RADIATION INJURY TO MEMBRANE PERMEABILITY OF ELECTROLYTES. Giichi Yoshii (National Inst. of Health, Bethesda, Md.) and Machiko Miyachi. J. Radiation Res. (Japan), 4: 31-8(Mar. 1963).

The present study was undertaken to elucidate the mechanism of the radiation injury to Na transport through the cell membrane, and of its recovery. It was found that Cs^{137} γ-ray irradiation in vitro caused inhibition of Na extrusion from the rat blood cell. Whereas no damage to Cl transport could be detected under the conditions of the present experiment. The failure of Na extrusion due to irradiation could be restored by the addition of ATP or DPN prior to irradiation, but could not be restored by glucose or nicotinamide. In the case of restoration by ATP, nucleosides contained therein seems to be transported into the cell and then synthesized into nucleotides, which, in turn, would serve in the restoration of Na extrusion activity. (auth)

13509 INDUCED MUTATIONS OF ASPERGILLUS NIGER BY GAMMA RAY IRRADIATION. Shoji Usami, Katsuhisa Yoshino, and Noboru Taketomi (Waseda Univ., Tokyo). Kogyo Kagaku Zasshi, 66: 1335-8(Sept. 1963). (In Japanese)

In continuance of earlier studies concerned with nitrogen mustard treatment and uv irradiation, an investigation was carried out to obtain high citric acid-yielding mutants of A. niger by Co^{60} γ irradiation. The spore suspensions were exposed to various doses ranging from 1.75×10^4 to 21.0×10^4 r, and survival rate and mutation rate were measured. When each sample was subjected to irradiation with 10×10^4 r or more, the survival rate was less than 4% and the mutation rate about 17%. The mutants obtained were classified into seven types by morphologic characteristics. The proportion of markedly or completely repressed sporulation types to all mutants increased as compared with those after nitrogen mustard treatment and uv irradiation. The mutant G-75, classified as sterile type (completely repressed sporulation), produced citric acid in a yield of 55% without the addition of methanol to the glucose-salts medium. When the mutant G-73, classified as normal type (the same as the parent strain in morphological appearance), was used, the addition of methanol greatly promoted the production of citric acid and the yield of citric acid was 71% of the sugar added to the medium. (BBB)

13510 EFFECTS OF DIAGNOSTIC IRRADIATION. Brian MacMahon (Harvard School of Public Health, Boston). Lancet, 1: 944(Apr. 27, 1963).

Evidence pertaining to the possible induction of leukemia by radiodiagnostic exposure is discussed briefly. (BBB)

13511 THE RELATION OF RADIATION DOSE TO SKELETAL DAMAGE FROM BONE-SEEKING ISOTOPES. Janet Vaughan (Churchill Hospital, Oxford). Lectures Sci. Basis Med., 9: 47-62(1961).

Effects of irradiation of bone from internally deposited radioisotopes are considered. Problems encountered in measurement of the absorbed radiation dose and assessing damage in bone are also considered. The calculated accumulated dose can only be approximate, and to estimate it over a long period of time a very large number of observations have to be made. Even so, measurement of absorbed radiation dose rate at any point in time is far easier to carry out than measurement of the damage caused since the effects of ionizing radiations on living tissue are so complex. To assess radiation injury in bone, crude histological criteria are still used and better methods of assessing tissue damage are needed. One of the great difficulties in the analysis of radiation damage to bone is to disentangle primary effects on the bone cells due to radiation from secondary effects due to radiation injury to blood vessels. Experimental observations suggest that, though areas of bone may be rendered avascular and the osteocytes die through radiation injury to blood vessels, radiation injures the cells of the osteogenic connective tissue directly, leading to abnormal cellular proliferation, abnormal apposition and resorption, and ultimately tumor formation. The characteristics of damage in bone tissues which will occur within six months to a year of administration of relatively large amounts of Sr^{90} are described. Detailed observations, attempting to relate absorbed radiation dose, from both Sr^{90} and P^{32}, to damage in the long bones of rabbits and rats, are described. Also discussed is the characteristic damage seen in radium poisoning and in the bones of dial painters. Figures are given to show the extremely high dose rates and accumulated dose that may be received by bone. The question of whether tumors can arise without gross histological damage is discussed, and it is concluded that this can only be settled by histological studies and dosimetry measurements made simultaneously in animals given small amounts of radioactive bone-seeking isotopes. It is emphasized that knowledge of the relation of radiation absorbed dose to radiation damage and carcinogenesis is still very inadequate. (BBB)

13512 ALTERATIONS OF BLOOD COAGULATION FACTORS DURING X-RAY TREATMENT OF CARCINOMATOUS WOMEN. Sandor Csoemoer, Rezso Hunka, and Miklos Szinnyai ([Municipal Public Health and Communicable Diseases Station,] Budapest). Magy. Radiol., 13: 93-100(1961). (In Hungarian)

Eight coagulation factors or parameters were studied in the blood of 34 carcinomatous women before and after x-ray treatment with 2000-r air doses, followed by 4000-r plus 1800 to 2000 mg-hr Ra doses, and then by 8000-r plus 3600 to 4000 mg-hr Ra. A 12-phase coagulation test was used. Tables are provided of the value obtained before treatment, after 2000 r, 4000 r plus Ra, and 8000 r plus Ra. These coagulograms revealed results resembling those of thrombocytopenia in $^2/_3$ of the cases. Thus a correlation was noted between the thrombocyte count, prothrombin consumption, and recalcification time. These three factors showed changes indicative of a hemorrhagic diathesis and displayed a linear rise with increased radiation doses. Similar, but irregular, alterations were observed with fibrinogen B, the number of positive cases increasing with the x-ray treatments, and the labile fibrinogen test became more positive. (BBB)

13513 IONIZING RADIATIONS AND CONGENITAL MALFORMATIONS. Domingos Delascio. Maternidade Infancia, 18: 313-30(July-Sept. 1960). (In Portuguese)

Evidence relating to the teratogenic action of natural and artificial radiation sources is discussed. Information obtained to date indicates that the most important source of artificial radiation is that encountered in diagnostic radiology, and that in quantity it is comparable with that from all natural sources combined. The possibility is expressed that this radiation has had, and is having an appreciable effect on the general population. Some aspects of these effects are emphasized, such as the well-documented fact that radiation can cause malformations of the fetus, particularly if it is exposed during the first months of gestation; this contraindicates its use during this time. Other precautions to be observed in diagnostic radiology are: women of child-bearing age should be irradiated only during the first half of their menstrual cycle, and gestating women not at all, since pelvic irradiation of pregnant women even during the last months of gestation may not be completely innocuous. The gynecologist is reminded that a radiation dose for hysterosalpingography should not exceed 25 r, and the pediatrician of the greater frequency of leukemia and neoplasias of the thyroid of children irradiated for thymus and tonsil enlargement. One-hundred-two references are cited. (BBB)

13514 A CONTRIBUTION TO THE STUDY OF VAGO-SYMPATHETIC EXCITABILITY DURING RADIATION SICKNESS. V. Jurkovic and L. Vokrouhlickii. Med. Radiol., 9: 53-7(Jan. 1964). (In Russian)

Infiltration of the cervical region of vagosympathetic nerves by a 1% procaine solution provokes in nonirradiated rabbits a statistically significant degree of occurrence of arrhythmia and alteration in the form of QRS complexes of the electrocardiogram; these changes can be prevented by a preliminary administration of atropine. On the sixth day after whole-body irradiation, the appearance of the mentioned changes is statistically significant to a lesser degree, but arrhythmias are more serious and cannot be prevented by atropine. These facts testify to an altered tone in the autonomic nervous system and a change in myocardial reactivity following irradiation, possibly as a consequence of certain organic changes producing a higher cardiac excitability during radiation sickness. (auth)

13515 SOME BIOCHEMICAL INDICES IN EXPERIMENTAL ANIMALS IN THE CHRONIC ACTION OF LOW DOSES OF GAMMA-RADIATION. S. A. Keizer, K. V. Ivanov, N. M. Timofeeva, and G. N. Ilyutkin. Med. Radiol., 9: 57-60(Jan. 1964). (In Russian)

Chronic irradiation of albino rats with gamma radiation (daily dose of 0.05 and 0.5 r) does not lead to changes in the content of blood sugar, residual nitrogen, and total blood protein, and DNA and RNA in the spleen and testicles. In the irradiated animals in remote periods there is seen a decrease of the oxygen capacity and catalase activity of the blood. In rabbits subjected to the daily effect of radiation (0.05 r) no changes were observed in the content of sugar, residual nitrogen and total protein of the blood. In irradiated rabbits there was a tendency to a reduced content of albumins and augmented level of globulin fractions of the blood. During selective investigations in experimental rabbits there was noted a diminished oxygen capacity of the blood. (auth)

13516 RESEARCH ON LEUKOCYTIC PEROXIDASE IN CHILDREN EXPOSED TO ROENTGEN THERAPY. N. Ansaldi and A. Balocco (Università, Turin). Minerva Pediat., 14: 741-7(July 14, 1962). (In Italian)

The first group of five subjects ranging in age from 14 days to 5½ months, affected with thymus hypertrophy, were treated with 10 doses of 50 r each. A second group, aged 3½ to 6 yr, included one case of malignant lymphogranuloma, one case of lymphosarcoma, and one case of Hand-Schuller-Christian disease; the first two received 10 doses of 200 r each; the last, 15 doses of 200 r. Peroxidase activity was determined cytochemically in peripheral leucocytes. In the first group, peroxidase-negative granulocytes ranged from 0 to 2.2% of the total; weak-reacting granulocytes from 7 to 15%; moderate-reacting granulocytes from 23.4 to 40.4%; strong-reacting granulocytes from 50.4 to 65.4%. At the end of the therapy the values were superimposable on the initial values, and variation during therapy was moderate. In the second group, variation in unreacting, weak-reacting, moderate-reacting, and strong-reacting granulocytes during the therapy was as follows: patient with malignant lymphogranuloma, 0, 1 to 19%, 24 to 77%, 17 to 68%; patient with lymphosarcoma, 0, 4 to 17%, 24 to 60%, 32 to 66%; patient with Hand-Schuller-Christian disease, 0, 1 to 9%, 2 to 68%, 27 to 98%. Definite inversion of moderate and strong reactions after every other irradiation was noted in these cases, but the final peroxidase values were again similar to the initial values. The sensitivity of the enzyme to ionizing agents is thus only moderate and a study of its changes in activity in leucocytes would not be sufficient for an assessment of possible radiobiological damage. (BBB)

13517 RADIATION-INDUCED PROTEIN LEAKAGE INTO THE SMALL INTESTINE. A. R. Bromfield and P. W. Dykes (Univ. of Birmingham, Eng.). Nature, 201: 633-4 (Feb. 8, 1964).

Studies on rats, maintained on a diet containing 20% anion exchange resin and subjected to anal suture before exposure to x radiation and the subsequent intracardiac injection of I^{131}-labeled human serum albumin at time intervals from 24 to 168 hr, showed that protein leakage occurred following exposure to 500 r x radiation. This leakage reached a maximum on the 4th and 5th days post-irradiation, which was before the period of maximum histological damage. No evidence of leakage was found after exposure to lower doses of x radiation. (C.H.)

13518 ENDOTOXIN-INDUCED NEUTROPHIL RESPONSE IN MINIATURE PIGS INGESTING STRONTIUM-90 DAILY. R. O. McClellan, Glenda S. Vogt, R. E. Kane, and F. F. Hahn (General Electric Co., Richland, Wash.). Nature, 201: 721-2(Feb. 15, 1964). (HW-SA-3292)

Biological effects of daily Sr^{90} ingestion were evaluated in female miniature pigs. Experimental animals were born to and sucked a dam ingesting 125 μC Sr^{90} daily. At six weeks of age they were given 31 μC daily doses of Sr^{90}, which was increased to 31 μC at three months and 125 μC at six months of age. Administration of the latter level was continued throughout the animals' lifetime. A purified Pseudomonas endotoxin was given intravenously via the anterior vena cava, and effects of a bacterial challenge were studied. An increase in neutrophils was noted in controls given the endotoxin, but was not evident in the Sr-fed pigs. The reduced neutrophil response in the animals fed Sr^{90} suggests that in the event of a bacterial stress requiring mobilization of increased numbers of neutrophils, their health could be severely compromised as compared with that of the controls. (H.M.G.)

13519 EFFECT OF IONIZING RADIATION ON UTERINE CONTRACTILITY. S. Natarajan and P. W. Dykes (Univ. of Birmingham, Eng.). Nature, 201: 723-5(Feb. 15, 1964).

Sensitivity of uterine muscle to commercial preparations of oxytoxin was studied in female albino rats given 750 r of x radiation. Increase in rate and magnitude of oxytoxin-induced contractility was observed in the irradiated animals, reaching a peak 24 hours after exposure. Factors possibly explaining the increased uterine sensitivity to hormonal stimulation are discussed. (H.M.G.)

13520 ACUTE BRAIN DAMAGE INDUCED BY X IRRADIATION WITH SPECIAL REFERENCE TO RATE AND RECOVERY FACTORS. R. H. Brownson, D. B. Suter, J. L. Oliver, and D. A. Diller (Medical Coll. of Virginia, Richmond). Neurology, 13: 1011-20(Dec. 1963).

Histopathologic studies were made of the brains of rats receiving limited head x irradiation of 3000 r delivered at the following dose rates: 930, 600, 300, and 150 r/min. No marked or consistent changes were revealed by physical examination before sacrifice or macroscopic analysis of gross brain after sacrifice at 1 to 48 postirradiation hours. Cerebellar granule cells demonstrated slight nuclear shrinkage and darkening of staining reaction (pyknosis). The severest response was elicited at the 930- and 600-r/min dose rates, becoming more pronounced from 1 to 24 hr after irradiation. At 48 hr, cerebellar granule cells were frequently normal or swollen in appearance and demonstrated a lighter staining reaction. Rossman-fixed material from animals that received 930- and 600-r/min dose rates demonstrated fine particulate granules of diastase-digestible periodic acid-Schiff (PAS) positive material scattered throughout the neuropil with a tendency to greater concentration on the surfaces or in the vicinity of capillaries and small blood vessels. This phenomenon increased from the first to the 24 hr after irradiation and decreased thereafter. Acute swelling of oligodendroglia leading apparently to necrosis reached a maximum 6 to 24 hr after irradiation, irrespective of the dose rate. Numerical counts and statistical methods were employed to evaluate a quantitative and qualitative analysis of the data, but there were no consistent trends or significant changes among the various stages of oligodendroglial degeneration. There was no significant difference between the damaged oligodendrocytes of the brain stem and those of the cerebral cortex. There was a significant difference between the damaged oligodendrocytes of the cerebellum and those of both the brain stem and the cerebral cortex. In the cerebellum, there was a significant difference between the 0 dose rate (control) and the 300- 600-, and 930-r/min dose rates. There was also a significant difference between the 150-r/min dose rate and the 600- and 930-r/min dose rates. For the cerebral cortex, there was a significant difference between the 0 dose rate and the 150-, 300-, 600-, and 930-r/min dose rates. The same conclusion of the cerebral cortex was made for the brain stem. Over-all analysis showed that the time and dose rate were significant at the 95% level. This effect is significant out of the third degree in time and the second degree in dose rate. However, it was concluded that effects of the dose rate in the range between 0 and 150 r/min requires further study. (BBB)

13521 OVARIAN REGENERATION AND PREGNANCY FOLLOWING MASSIVE RADIOTHERAPY FOR DYSGERMINOMA: REPORT OF A CASE. B. Gans, C. Bahary, and B. Levie (Beilinson Medical Center, Petah Tikva, Israel). Obstet. Gynecol., 22: 596-600(Nov. 1963).

Birth of a normal infant is described in the case of a woman receiving large doses of abdominal x irradiation 10 yr previously for metastatic dysgerminoma. The primary tumor of one ovary had been removed at that time.

Despite the unusually high dose of x rays administered to the remaining ovary, it nevertheless regained normal activity. This activity was minimal for nearly 10 yr, after which period the patient conceived and delivered normally. Then, and for the first time, the hormonal assay was normal. It was unexpected that the remaining ovary could resume normal function after being exposed to a total tissue dose of 1740 r divided into three series, one of 840 r in 23 days, a second of 450 r in 14 days with an interruption of 49 days, and the third series of 450 r in 13 days, two yr later. Previous studies have shown the varied response of the ovaries to irradiation and the recuperative power they possess. The ovary is essentially a radiosensitive organ, but under certain conditions it is radioresistant, especially in young women. It is thought that the maturing follicles are destroyed first by irradiation and then the resting primary follicles. The fact that an apparently healthy child was born in this case does not rule out that the generation deriving from this child may show mutation and malformation due to radiation injuries of the chromosomes or genes. It is possible that the dosage of 1740 r that was administered to the resting primary follicle years before fertilization caused reversible damage. Similar cases from the literature are reviewed. This case points out the high radiosensitivity of dysgerminoma and favors conservative operation in young patients. (BBB)

13522 BREEDING EXPERIMENTS ON MEDICINAL PLANTS. 26. THE HEREDITARY CHARACTERISTICS OF THE R1705 MUTANT OF DATURA STRAMONIUM L, VAR. GODRONII DANERT. E. Steinegger and F. Zbinden (Universität, Bern). Pharm. Acta. Helv., 36: 74-9(1961). (In German)

Examination of hereditary characteristics of the R 1705 mutant produced by x irradiation showed that, from mutants with reduced growth and low alkaloid content, alkaloid alkaloid-rich plants can be cultivated by crossing with the parent strain (RK 11). The mutant proved to be of recessive character. The F_1 generation had the characteristics of the original plant, while in the F_2 generation there was a 1:3 split, according to the rules of monohybrid splitting. In the F_2 generation the radiation-altered characteristics of mutant R 1705 collectively act as a single factor difference. The size of the plant, number of leaves and fruit, as well as the alkaloid content, of the parental, F_1, and F_2 generations have been determined. The F_1 generation showed strong positive heteroesis regarding plant size and alkaloid production. The number of leaves was greater than that of the parental plant. The water content of the fresh leaves of F_1 was 82.9% as compared with 80.5% of the dominant and 83.9% of the recessive parental plant. The percentage alkaloid content, as well as the total alkaloid content of leaves per plant and per soil surface, is also significantly higher than that of the control plant. Along with the approximately 70% higher alkaloid production and fresh leaf weight per plant, the fresh weight of roots also increased by approximately 30%. (BBB)

13523 BREEDING EXPERIMENTS ON MEDICINAL PLANTS. 27. ROENTGEN MUTATIONS AND ACTIVE SUBSTANCE CONTENT IN DATURA. E. Steinegger and F. Zbinden (Universität, Bern). Pharm. Acta Helv., 36: 543-7(Oct. 1961). (In German)

The changes in alkaloid content of the Datura stramonium var. godronii are considered. About 1000 plants cultivated from irradiated and nonirradiated seeds were examined for changes in total alkaloid content. In about 1.5% of the plants the alkaloid content changed considerably, the decreases being more marked than the increases. Completely alkaloid-free plants, however, were not produced, in spite of the fact that occasionally the alkaloid content was so low that it could no longer be determined. There were two groups of mutants with increased alkaloid content. Some pharmaceutically important plants with higher total alkaloid production per plant and with lowered alkaloid drug yield had double chromosome numbers and proved to be autotetraploid. However, the alkaloid contents of these plants were not higher than those of the artificially cultivated polyploids. The alkaloid content was evaluated by paper chromatography, which made possible the extraction of minute amounts of water-soluble basic amines as well as preventing the secondary changes of alkaloids. New alkaloids were not detected. Scopolamine content was found to decrease with age of the plant. In some mutants a reciprocal change in the amounts of some alkaloids could be demonstrated. A mutant containing a large amount of cuskohygrine was detected. (BBB)

13524 REDUCTION AND OXIDATION BY BIOLOGICAL EFFECTS OF RADIATION. P. Wels. Photochem. Photobiol., 2: 267-323(Aug. 1963). (In German)

Studies are compiled on the biological effects of radiation. An attempt is made to bring the studies under the simple viewpoint of oxidation and reduction. The first of the three main sections deals with the accelerating effect of ultraviolet rays on the process of reduction within the skin which occurs at the sulfhydryl groups of the germinal layer after exposure to light. The reduction investigated concerns end- and exogenous substances which are brought into contact with the sulfhydryl of the germinal layer by means of transfusion in the living pig's ear, in part, and also by immediate rinsing of the skin stripped from the ear. The third main section gives a description of the photochemical production of sulfhydryl groups and other reducing groups originating from ultraviolet radiation of proteins, amino acids and sugars. Other radiation effects are also mentioned, particularly the coagulation of protein, inhibition of growth and hemolysis. The second main section contains theoretical discussions relating more recent literature on radiation to older studies. The discussion is also extended to more general physiological and pharmacological problems related to medical radiology. The introduction and conclusion refer to the position of pharmacology within the field of medical radiology. (auth)

13525 COMPARISON OF THE EFFECTS OF ULTRAVIOLET RADIATION ON THE INTRACELLULAR CATALASE OF AEROBIC AND ANAEROBIC YEAST. J. G. Kaplan (Dalhousie Univ., Halifax, Can.). Photochem. Photobiol., 2: 333-8(Aug. 1963).

Suspensions of aerobic and anaerobic yeast were subjected to ultraviolet radiation (principally 254 mμ) under closely comparable experimental conditions, and changes in the level and in the temperature dependence of their catalase activity were determined. Qualitatively, the effects of uv on the enzyme of the anaerobic cells were similar to those on that of the aerobic cells. The effect of uv on the anaerobic catalase differed from that on the aerobic enzyme in the following respects: a considerably greater dose of uv was necessary in order to attain the maximum activity and the minimum activation energy of the enzyme-substrate system; a far greater dose was required before appreciable photoinactivation of the maximally active enzyme occurred; photoinactivation proceeded at less than one-half the rate; the uv-induced increase in the catalase activity of the suspension was virtually complete before appreciable reduction in activation energy occurred. The first three of these differences

were interpreted in terms of a model, which pictures the anaerobic catalase as being tightly bound to an intracellular chromophore group. (auth)

13526 INVESTIGATION OF THE COURSE OF BONE MARROW REPOPULATION IN POSTIRRADIATION CHIMERAS OF RABBITS WITH PELGER'S ANOMALY. Przemyslaw Czerski, Olgierd Rosiek, and Jan Sablinski (Medical Academy, Warsaw). Polskie Arch. Med. Wewnetrznej, 32: 825-8(1962). (In Polish)

Whole-body x irradiation doses of 1100 r (600 r + 500 r 24-hr later) were given 26 rabbits weighing 2.5 to 3 g, and some were injected with bone marrow cells from rabbits with the Pelger anomaly. In the recipient rabbits surviving 30 days or longer, circulating leukocytes showing the Pelger trait could be found. The proportion of Pelger granulocytes reached a maximum of 82% 14 days postirradiation, then declined to about 15% at 120 days, and disappeared from the circulation after 240 days. Normal peripheral cells showed an inverse relation, that is, are at minimal levels on the 14th day after irradiation. Donor (Pelger) cells could also be identified in the bone marrow of the surviving recipients. At the peak level of circulating Pelger cells (82% of the granulocytes at 14 days), 47% of the erythroblastic and 45% of the megakaryocytic cells were of donor (Pelger) origin. These results indicate the usefulness of this method of identification of the origin of peripheral and bone marrow cells in radiation chimeras. (BBB)

13527 EFFECTS OF GAMMA RADIATION ON DEVELOPMENT OF DIROFILARIA UNIFORMIS IN ANOPHELES QUADRIMACULATUS. Ralph E. Duxbury and Elvio H. Sadun (Walter Reed Army Inst. of Research, Washington, D. C.). Proc. Helminthol. Soc., Wash. D. C., 30: 263-5 (July 1963).

Studies were made in an effort to determine the effect, if any, that subjecting mosquitoes to irradiation prior to exposure to filarial infection has on the number of developing larvae and on their distribution through the head, thorax, and abdomen. Similarly, studies were conducted to determine whether irradiation of mosquitoes that had ingested blood containing microfilariae influenced the number, growth, and distribution of developing larvae. For irradiation prior to infection, mosquitoes collected 4 to 5 days after emergence were exposed to 10,000, 20,000 and 40,000 rep at a rate of 2000 r/min. In mosquitoes irradiated 24 hr prior to infection, more larvae were found in each of the irradiated groups than in the nonirradiated infected controls; however, the difference was significant only for the mosquitoes exposed to 10,000 rep. The mortality rates during the 10-day period ranged from 5% in mosquitoes irradiated at 40,000 rep, and subsequently infected, to 12% in the infection controls. In mosquitoes irradiated 24 hr after infection, irradiation produced a marked reduction in the numbers and growth of larvae in the mosquitoes as compared to the controls. Migration of larvae from the abdomen to the thorax and head did not occur in any of the irradiated mosquitoes. An additional experiment was conducted to determine whether smaller irradiation doses (1000, 2000, and 4000 rep) would have a similar effect on the development of the larvae. Dissection on the tenth day revealed no significant differences in numbers, size, development, and/or location of larvae in mosquitoes exposed to 1000 and 2000 rep as compared to the controls. However, at 4000 rep there was a significant reduction in the numbers of larvae and as in the previous experiment larvae in the abdomen developed only to the sausage stage. Mortality rates among mosquitoes used in these experiments again followed no pattern that could be attributed to irradiation effects. The results of the first experiment, in general, indicate that irradiation renders the mosquitoes more susceptible to infection and therefore may increase their effectiveness as vectors. On the basis of this experiment it is not possible to determine whether the greater susceptibility of mosquitoes irradiated before infection is hereditary. The results of the second experiment indicate that an exposure of microfilariae to irradiation caused a marked reduction in the numbers of developing larvae and drastically inhibited the normal growth of those larvae which survived. (BBB)

13528 TECHNOLOGICAL EFFECTS OF GAMMA IRRADIATION OF WHEAT. Max Milner (United Nations Children's Fund, New York). Proc. Intern. Congr. Biochem., 5th, Moscow, 1961, 108-32(1963).

Extensive literature appearing in the past six years suggests that few if any useful modifications of wheat and flour are produced by gamma irradiation. Deinfestation by treatments of 25,000 to 50,000 rep was proposed, but more information is needed about possible deleterious effects. Fungi, the cause of deterioration of damp grain, can be eliminated by irradiation levels around 250,000 rep, but damage to germination, starch, and protein, as well as darkening due to non-enzymatic browning, question the practicality of such treatment for improving storage properties. A decrease in power consumption in milling occurs, probably related to radiation-splitting of starch, which also involves decrease in dextrin chain length and gelatinization viscosity, as well as increases in maltose value. An increase in the soluble pentosans and loss of their gelling characteristic when treated with oxidizing agents is also observed, paralleling the appearance of major deterioration in breadmaking quality and loss of bromate response. Reduction of grain viability with irradiation is not paralleled by a corresponding drop in formazan production from TTC, due apparently to the formation of browning products, reducing in character (reductones), at high radiation levels. Evidence concerning the effects of irradiation on dough and breadmaking properties is conflicting but the improvement claimed in weak wheats can be explained on the basis of a stimulation in gas production during dough fermentation due to increase in starch degradation products; probably it does not involve beneficial modification of the gluten. Thus, when irradiated flours are baked with optimum quantities of sugar, amylase supplements and oxidizing agents, no improving effect due to irradiation is observed and the damage to bread properties is progressive; it is reversible in terms of loaf volume but not crumb grain by treatment with potassium bromate, but only at moderate irradiation levels. Reduction of dough mixing time and water absorption, as well as adverse changes in bread flavor and rate of staling are other effects of irradiation. (auth)

13529 EFFECT OF γ-RAYS ON THE BIOCHEMICAL PROPERTIES OF WHEAT. N. I. Sosedov and A. B. Vakar (All-Union Grain Research Inst., Moscow). Proc. Intern. Congr. Biochem., 5th, Moscow, 1961, 133-42(1963).

Progress in the Soviet Union on radiation effects on biochemical and baking properties of wheat is reported. Biochemical analysis of the various forms of nitrogenous substances in wheat with moisture contents of 13.4 and 25.8 percent after irradiation with gamma rays shows that the radiation effects on gluten are dependent upon moisture content. Gluten in dry grain exposed to gamma rays became weak, inelastic, and too extensile while that in moist grain became excessively stiff with consequent loss

of extensibility and cohesion. In dry irradiated grain increases were found in protein substance solubility and protein splitting, whereas in irradiated grain with a higher moisture content, there was less protein splitting and solubility of protein substances was reduced. When the moisture content was 16.4 percent, radiation damage was least, the two opposite sets of deleterious effects being somewhat (not completely) balanced. The different effects of the same radiation doses on moist and dry grain was confirmed by spectrophotometric examination. Large gamma doses increase the quantity of reducing sugars and decrease the starch content. These carbohydrate changes are more pronounced with dry than with moist grain. It is concluded that with present knowledge and techniques the method of radiational treatment of grain cannot be recommended for practical use. (H.M.G.)

13530 EFFECTS OF α RADIATION ON PLANT CELLS. Richard Biebl and Walter Url (Universität, Vienna). Protoplasma, 57: 84-125(1963). (In German)

The biological effects of alpha particles on cells of onions (Allium cepa) and other plants were investigated. Po^{210} served as the source of α particles. Comparisons of radiation resistance of cells of different plants, the dose dependence of radiation effects, seasonal changes in radiation sensitivity, survival times after different strengths of irradiation, cytomorphologic and cell-physiologic observations, and regeneration ability are discussed. Plasmolytic effects of various solutions on normal and irradiated cells were observed. (M.C.G.)

13531 MITOTIC DELAY FOLLOWING X-RADIATION IN THE MERISTEM CELLS OF PISUM SATIVUM. J. Van't Hof (General Electric Co., Richland, Wash.). Radiation Botany, 3: 311-14(Dec. 1963).

A decrease in the number of dividing cells in the root meristem of Pisum sativum was observed following x-ray exposures of 100, 200, and 400 r. Using the technique of labeling cells with tritiated thymidine, it was found that radiation-induced blockage of cells passing from the S to G_2 interphase period was responsible for mitotic delay. The duration of effect was dose dependent, but the initial drop in the number of dividing cells was independent of dose. When tritiated thymidine was administered immediately following exposure, the percentage of labeled interphase cells was reduced below that of the control. However, when the label was administered two hr after exposure to x-rays, no difference between controls and irradiated meristems was observed. It was concluded that mitotic delay resulted from radiation-induced changes in the cells that were not exclusively involved in DNA synthesis but rather with the transition between the S and G_2 conditions. (H.M.G.)

13532 INDUCTION OF PHOTOCONDUCTIVITY IN BARLEY SEEDS BY IONIZING RADIATIONS. John Read (Wakari Public Hospital, Dunedin, N. Z.). Radiation Botany, 3: 315-19(Dec. 1963).

The electrical conductivity of a dry barley seed is increased many times by exposure to a radiation dose of the order of 10^5 rads. At room temperature this conductivity then diminishes, halving every few hours, in much the same way as does the photoconductivity induced in plastic insulators by radiation. If the irradiated seed is heated to 90°C the conductivity changes occur within approximately 1 hr instead of two or three days. Presumably electrons ejected by the radiation are held in traps from which they are transferred into the conduction band by fluctuations in thermal energy. Possible connections between this phenomenon, the radiation biology of barley seed and spin resonance measurements are discussed. (auth)

13533 SOME RESULTS IN RADIOGENETICAL EXPERIMENTS WITH TOMATO VARIETIES. A. Bianchi, G. Marchesi, and G. P. Soressi (Catholic Univ., Piacenza, Italy and Università, Milan). Radiation Botany, 3: 333-43(Dec. 1963).

Seeds of six tomato cultivars were x-rayed (7–14–21 kr) after having been water-equilibrated in a $CaCl_2$ desiccator. The following responses were considered: germination (unaffected); germination delay (induced uniformly in the different genotypes and proportionately to the x-ray doses); seedling height depressed differentially; time for the first flowering similarly influenced; the phase between the first flowering and the ripening, unaffected; fruit size diminished in 1–2 cultivars; plant height increased, except in one cultivar, in which it is reduced; the variance of the irradiated material for most of the studied traits, not consistently affected; the number of seeds per fruit progressively reduced; but no difference is found between the first and the last fruit considered, except with severe irradiation; mutations are induced in both types of fruits at about the same rate. The results obtained suggest that while gametic selection operates to a marked degree, intrasomatic selection seems of minor importance, although detectable following the heaviest treatment. (auth)

13534 STUDIES ON SOME NUCLEAR FACTORS CONTROLLING RADIATION SENSITIVITY AND THE INDUCED MUTATION RATE IN EU- AND PARA-SORGHUM SPECIES. Satya Nirula (Indian Agricultural Research Inst., New Delhi). Radiation Botany, 3: 351-61(Dec. 1963).

The interaction between the length and number of chromosomes, DNA content, and nuclear volume in relation to radiosensitivity was studied in S. nitidum and S. purpureo-sericeum, two species with 2n = 10 belonging to the Para-Sorghum group and S. vulgare, a cultivated Eu-Sorghum species with 2n = 20. The LD_{50} dosages for Co^{60} gamma- and 50 kV x-irradiation of seeds of S. nitidum were respectively 26,060 and 16,000 r and for S. vulgare were 65,160 and 63,680 r. With regard to radiosensitivity, S vulgare behaves like a polyploid. The total length of the chromosome complement varied in the ratio 1:.16:1.33 in S. vulgare, S. nitidum, and S. purpureo-sericeum, the ratio of nuclear DNA contents being 1:1.70:1.62. The absence in these three species of any consistent relationship between chromosome length and DNA content may be due to the presence of variable amounts of heterochromatin. S. vulgare and S. purpureo-sericeum had a similar nuclear volume but no well defined proportionality existed between total chromosome length and nuclear volume. Results suggest that in the three Sorghum species: no direct relationship may exist between chromatin length and DNA content in species characterized by chromosomes having distinct eu- and heterochromatic segments; no well defined relationship may exist between nuclear volume, chromatin length and DNA content. Nuclear volume alone, therefore, may not always be a reliable index of radiation sensitivity, and 'tetraploid' Sorghum vulgare with smaller chromosomes and lesser DNA content is more resistant to radiation than the diploid Para-Sorghum species with much longer chromosomes and higher DNA value. Phenotypic mutations occurred in S. vulgare but were absent in the Para-Sorghum species. It is suggested that diplontic selection effects may be responsible. (auth)

13535 RADIATION PHYSIOLOGY OF FRUIT—ASCORBIC ACID, SULFHYDRYL AND SOLUBLE NITROGEN CONTENT OF IRRADIATED CITRUS. Roger J.

Romani, Jan Van Kooy, Lily Lim, and Basil Bowers. Radiation Botany, 3: 363-9(Dec. 1963).

Emphasis is given to the initial effects of radiation and how they may reflect on the mechanisms of radiation injury as well as on the physiological responses of the fruit. Increased solubilization of the citrus tissues which occurs after massive doses of radiation can influence greatly the expression and interpretation of subsequent analyses. This is demonstrated for ascorbic acid and sulfhydryl measurements. Several parameters of irradiation have been controlled or defined to categorize firmly the effects of the treatment. (auth)

13536 MORPHOLOGY OF THE ULTRASTRUCTURE OF NEUTROPHYLIC GRANULOCYTES AND LYMPHOCYTES "IN VIVO" AFTER WHOLE-BODY IRRADIATION IN THE RABBIT. Giuseppe Poggi Longostrevi (Università, Milan). Radiobiol. Latina, 6: 17-27(Jan.-Mar. 1963). (In Italian)

A morphological analysis is presented of the ultrastructure of leucocytes and lymphocytes of rabbits exposed to a single high dose (800 r) whole-body irradiation. Modifications were observed both in the nucleus and the cytoplasm. The nucleus is first vacuolized and then shows pycnosis and fragmentation. The cytoplasm shows a decrease of specific granulations and the presence of lipid material. (auth)

13537 MODIFICATION OF THE HEPATIC ULTRASTRUCTURE IN ANIMALS IRRADIATED AND TREATED WITH SYNKAYVITE. G. Poggi Longostrevi and L. Lombardi (Università, Milan). Radiobiol. Latina, 6: 29-36 (Jan.-Mar. 1963). (In Italian)

The morphology of the liver of rats exposed to whole-body irradiation and given Synkayvite was investigated with the electron microscope. The Synkayvite had a radiosensitizing effect. The study showed modifications of the cytoplasmic ultrastructure of the hepatocyte such as alterations of the mitochondria (swelling and irregularity of the borders) and the endoplasmic reticulum (decrease of the numbers and dilatation of the cavities of the granular reticulum), and the presence of intensely osmiophilic granula in Golgis apparatus. These data are discussed with respect to their relation to recent biochemical observations on the mechanism of action of phosphoric esters of vitamin K. (auth)

13538 THE EFFECT OF Co^{60} GAMMA RADIATION ON THE DEVELOPMENT IN VITRO OF LIMB ANLAGE OF MOUSE EMBRYOS. A. Ghisellini and M. Ladu (Comitato Nazionale per l'Energia Nucleare, Rome). Radiobiol. Latina, 6: 61-87(Jan.-Mar. 1963). (In Italian)

The effect of Co^{60} γ rays on the anlage of anterior limbs of mice embryos explanted between 11.5 and 13.5 days of gestation and irradiated with doses of 92, 185, 330, 660, and 950 r and cultivated in vitro on agar was investigated. The limbs explanted at 11.5 days were shown to be the most sensitive to radiation. Diffuse degenerations of the whole limb and particularly of its terminal extremity or autopodium were found in the majority of cultures exposed to 185 r. The degeneration was constant for all higher dosages. The dose of 92 r did not show any visible effect. Syndactylism is found with the same frequency in the non-irradiated controls as in the irradiated samples. In limbs explanted at 12.5 and 13.5 days, a considerable degeneration of the mesenchyme is found, but the cartilage, regardless of the irradiation dose, is very resistant. In explantates of 12.5 days treated with 925 r, an increased deposition of cartilagenous ground substance and a decrease of the cellular size were found in about half the cultures. Some of the nuclei were shown to be flattened. The determination of the number of degenerate cells and of mitoses in the first 36 hr of culture on a group explanted at 13.5 days and exposed to 330 r indicate that the degeneration of the mesenchyme affects up to 40% of the cells, but it is never higher than 5% for the perichondrium. In the cartilage the degeneration is limited to 1% of the cells and does not differ significantly from that of nonirradiated controls. The mitosis curve shows that the irradiation causes an immediate block, reaching, some 4 hr after irradiation, values near zero. The number of mitoses increases again and, after 18 hr, reaches values higher than those of controls. This is interpreted as being an effect of synchronization of mitoses previously blocked. (auth)

13539 MORPHOLOGICAL AND ELECTROCARDIOGRAPHIC STUDY ON THE DELAYED EFFECTS OF RADIATION ON THE HEART OF RABBITS. A. Malaspina, R. Sorrentino, and F. Fedele (Ospedale Maggiore, Novara, Italy). Radiobiol. Latina, 6: 89-98(Jan.-Mar. 1963). (In Italian)

A previous study on the early effects of radiation on the rabbit heart was completed by extending the examination period up to 120 days. The rabbits were exposed to 10,000 and 15,000 rad Co^{60} γ radiation administered in a single dose in the precardial region. In only three animals, exposed to the higher dosage, were slight electrocardiographic variations found. These variations consisted of a progressive elongation of the Q-T tact (2 cases) and flattening of the T wave (1 case). Clear histomorphological alterations of the myocardial fibrocells could not be established in any case. (auth)

13540 ON THE CHANGE OF ADRENAL FUNCTION IN ACUTE RADIATION INJURY. G. David, L. Faradi, and D. Tanka (Rheumatology and Balneology Inst., Budapest). Radiobiol. Radiotherap., 3: 91-102(1962). (In German)

Corticosterone levels in effluent adrenal vein blood were followed in rats following $LD_{50/30}$ (800-r) whole-body x irradiation. Steroid synthesis was also measured in adrenal slices of these rats. Changes in the corticosterone content of the venous blood showed two phases during radiation sickness: an increase the fifth day and on the tenth day normalization of surviving rats. The changes of the hormone-synthesizing ability also showed two phases: increase increase in the first 24 hr postirradiation and a slight increase later. Histological and histochemical examinations showed necrobiotic and hyperplastic changes in the adrenal gland. The values for hormone production and the clinical course both affirmed that in the early phase the hormone-synthesizing capacity of the adrenal glands is heightened; the glands, however, do not secrete the hormone into the circulation. At the beginning of radiation disease the hormone output is markedly increased; hormone synthesis, however, is normal. In the third phase with recovery from the disease, the hormone secretion and synthesis are nearly normal. With cases later ending fatally the synthesizing capacity may remain unchanged, whereas the hormone output practically stops. Some discrepancies between the hormone production and the histological findings were noted. (BBB)

13541 INVESTIGATIONS OF THE CHANGE OF THE DNA CONTENT IN THE BONE MARROW OF GUINEA PIGS AND RATS FOLLOWING IRRADIATION. W. L. Strassner, R. Neubert, and I. Pradel (Humboldt-Universität, Berlin). Radiobiol. Radiotherap., 4: 593-603(1963). (In German)

From the radioinduced reduction of the DNA content in the bone marrow of guinea pigs and rats the dependence

on radiation dose and time was investigated. The radiation response in the bone marrow of rats appeared earlier than in the bone marrow of guinea pigs. Following whole-body irradiation with 25 r significant differences from the normal value did not appear on one of the days fixed for investigation after irradiation in the bone marrow of either species. The reductions of DNA, which appeared on the first day after irradiation following the application of 50 r, were plotted and tabulated for radiation doses of 50, 100, 200, 400, and 800 r in dependence on time following irradiation. The significance of differences between radiation effects of the same radiation doses on different days and radiation effects of different radiation doses on the same days is emphasized. (auth)

13542 ARTERIAL BLOOD PRESSURE IN THE COURSE OF RADIATION SICKNESS IN DOGS. Karel Zaruba (Charles Univ., Königgrätz, Czechoslovakia). Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove, 6: 35-8 (1963).

Blood pressure was measured in dogs before and after irradiation using a direct method. In the first group irradiated with a dose of 500 r a moderate, gradual increase in systolic, diastolic, and mean arterial pressure, with a significant increase in the systolic pressure, was observed 42 days after irradiation. In animals irradiated with 600 r, a slight decrease in the pressure values was observed which was statistically significant eight days after irradiation. Similar changes occurred also in the third group irradiated with 800 r, the decrease being not statistically significant. It is concluded that in radiation sickness induced by whole-body irradiation up to a lethal dose there was no marked, lasting hypotension which might influence the course of radiation sickness. It is possible that these measurements did not detect temporary hypotension as previously described in the first hours following irradiation. It is suggested that it is important to measure the blood pressure without anesthesia which may, especially in irradiated animals, considerably influence blood pressure toward hypotension. (BBB)

13543 CYTOGENETICAL STUDIES ON ASYNAPTIC RICE PLANT (ORYZA SATIVA L.) INDUCED BY X RAY. Taira Katayama (Kyushu Univ., Fukuoka). Senshokutai, 48: 1591-1601(June 1, 1961). (In Japanese)

Development of asynaptic rice plants was induced by x irradiation in X_2 generation of the rice varieties Asahi and Aikoku. It was difficult to distinguish morphologically such asynaptic plants from the normal ones except for their high sterility and specific awn character. These asynaptic plants were also characterized by erect panicles and by their continuously producing fresh tillers until after the normal ones had stopped growth and attained their maturity. The asynaptic plants showed very high sterility, attaining a seed set of less than 1%. No seeds could be obtained from both reciprocal crosses between normal and asynaptic plants. From the segregating behavior of this asynaptic character in X_2, in the X_3 generation, and in the open-pollinated offspring of the asynaptic plants, it was concluded that the asynaptic character is inherited by a simple recessive gene which causes complete failure of chromosome pairing at the early stage of meiosis. No pairings of homologous chromosomes were ascertained at zygotene and pachytene stages in these asynaptic forms. The number of paired chromosomes at diakinesis and at M1 varied from 0 to 12, and the mean number varied from plant to plant, and from one another to another in the same plant. The average number of chiasmata per bivalent was 1.03 for the asynaptic plant and 2.21 for the normal one when all chromosomes, paired and unpaired, were taken into consideration. However, it was 1.83 for the asynaptic plant and 2.21 for the normal one when only paired chromosomes were counted. On the other hand, the numbers of chiasmata on each nucleolar chromosome were 2.14 and 2.11 for the asynaptic and the normal plants, respectively, if only paired chromosomes were considered, and 1.36 and 2.11 for the asynaptic plant and the normal one, respectively, if all chromosomes were taken into consideration. At anaphase I, various numbers of lagging chromosomes were usually observed. The asynaptic plants showed irregular behavior of univalent chromosomes, resulting in the complete abortion of their pollen grain. (BBB)

13544 EFFECT OF X-RAY IRRADIATION ON GROWTH, SEXUAL MATURITY AND FERTILITY OF RATS SUBJECTED TO RADIATION EXPOSURE AT AN AGE OF SEVEN DAYS. III. PROTECTIVE ACTION OF CYSTEINE. Yung-chou Hsiung. Shih Yen Sheng Wu Hsueh Pao, 8: 91-6 (1962).

Female rats were subjected at the age of seven days to a single total irradiation with x rays (XRI) in a dose of 400 r. An appreciable lowering of mortality was found in animals to which injection of cysteine (1) was administered prior to XRI; also hair-loss was obviated and retarded growth of animals during 2 months following XRI was mitigated. 1 is not capable of preventing the onset of radiation injury to the ovaries, for which reason the percentage of matings that produced offspring in females treated with 1 was the same as for the unprotected animals. However, the number of females that mated with males was appreciably increased in the group of animals that received 1. This is apparently due to the fact that SH-compounds exert a protective action in relation to the secretory activity of the ovaries on XRI. (OTS)

13545 THE REGENERATION OF THE CONTENTS OF THE LENS CAPSULES OF RABBITS AFTER REMOVAL OF CATARACTS INDUCED BY X-IRRADIATION. D. Stenhouse Steward (Univ. of Hull, Eng.). Trans. Ophthalmol. Soc. U. K., 82: 205-21(1962).

A study of cataract formation was made, but instead of inducing cataract by pricking the capsule or by chemical means it was induced by irradiation in an attempt to disturb the lens-forming cells without at the same time injuring other structures. Lens changes were studied macroscopically and histologically after unilateral x irradiation of the rabbit eye. After 1400 r, characteristic vacuoles appeared in the posterior lens cortex six months later. These changes, progressive for a few weeks, showed little advance thereafter up to three yr from the date of irradiation. This accords with the earlier conclusions that adult rabbits need a higher dose of x rays than younger ones do to produce any change at all and that these changes of moderate degree are first seen after a latent period of several months and tend to spontaneous arrest. A larger dose of 2600 r provoked immediate severe reactions with permanent damage to lids, conjunctiva, and cornea, which made examination difficult. Lens changes were seen after nine days, with appearance of fine bubbles. These bubbles could not be found again until three months after irradiation, when they became prominent. This change progressed in a few weeks to give complete milky opacity. These cataracts proved so firmly adherent to their capsules that evacuation was difficult. In other rabbits which received 1100-r eye irradiation, the irradiated lens capsule was removed and a fragment of fetal tissue implanted. This resulted in regeneration of a transparent lens whereas the irradiated nonimplanted capsules re-

mained cloudy. The contents of nonimplanted capsules were so cloudy that skiascopy was impossible and only an indeterminate view of the fundus reflex was obtainable by direct ophthalmoscopy at high power. The lenses regenerated in the presence of implanted fetal tissue, however, were homogeneous and transparent so that some estimate of the hypermetropia of these eyes could be attempted by ophthalmoscopy and skiascopy. Their ametropia began to diminish four months after operation and it progressed towards emmetropia in a further two months. Vacuoles appeared in the lens of the younger control (irradiated) rabbits after two months and of the older after three months, and advanced slowly so that even a year after irradiation they constitute little impairment of the optical properties of the eye. The lenses of these control animals are clearer than those of animals subjected to operation. The structural defects and the refractive properties of irradiated, regenerated lenses are described in detail. (BBB)

13546 WHAT BIOLOGICAL MECHANISM IS THE BASIS FOR THE RADIATION DEATH OF CELLS? RESULTS OF STUDIES ON YEAST CELLS. W. Laskowski (Freie Universität, Berlin). Umschau Wiss. Tech., 64: 42-6(Jan. 15, 1964). (In German)

The results of radiogenetic studies on yeast cells are reviewed. The development phases of yeasts are first described. The detection of recessive and dominant lethal mutations and plasmatic lethal effects are discussed, and the relative contribution of the individual lethal effects to the radiation death of the yeast cells is considered. The ratio of radioinduced mutation rates to lethal function gene states is discussed. (J.S.R.)

13547 THE EFFECTS OF GAMMA RADIATION (Co^{60}) AND VITAMIN K_5 ON YEAST CULTURES. H. Gaisch and K. Kaindl (Reaktorzentrum, Seibersdorf, Ger.). Z. Naturforsch., 18b: 1070-2(Dec. 1963). (In German)

For a dose of 10^5 rad Co^{60} radiation only the reproduction of yeast was stopped. The addition of 1 mg % vitamin K_5 stopped fermentation. In simultaneous treatment of the yeast with vitamin K_5 and irradiation both effects appeared in juxtaposition. A sensitization of the yeast against irradiation by vitamin K_5 could not be observed. (tr-auth)

13548 IONIZING RADIATION, RADIATION EFFECTS, RADIATION MEASURING TECHNIQUES, AND RADIATION PROTECTION. P. Marmier (Eidgenossische Technische Hochschule, Zurich). p.3-7 of "Industrielle Anwendung von Radioisotopen." [Bern, l'Association Suisse Pour l'Energie Atomique, 1963]. (In German)

The characteristics of radiations associated with radioactive decay of nuclei are briefly described. Mention is made of the interactions of charged particles and gamma radiation with matter, leading to their absorption. The ionization effects can be utilized for detection; in this connection the various principal types of counters are presented. Biological effects ensuing from ionization in tissue are summarized. (auth)

13549 PRESERVATION OF FOOD AND STERILIZATION OF MEDICAL AND PHARMACEUTICAL PRODUCTS. K. Kaindl and H. Gaisch (Institut fur Biologie und Landwirtschaft, Reaktorzentrum Seibersdorf, Austria). p.36-47 of "Industrielle Anwendung von Radioisotopen." [Bern, l'Association Suisse Pour l'Energie Atomique, 1963]. (In German)

A survey was made of the efforts of research in the field of food irradiation. The radioconservation of easily perishable foods (meat, poultry, and fish), not easily perishable foods containing more than 20% water (e.g., potatoes, fruit, fruit juice), and not easily perishable dry foods (less than 20% water) such as maize, wheat, rice, is discussed. In special cases irradiated food could be cleared for human consumption. However research is still considered necessary before a general application can be made. The danger of creating induced radioactivity in irradiated foods can be excluded with energies up to 4 Mev. The sterilization of medical and pharmaceutical products with the help of ionizing radiation can replace heat and gas sterilization. The costs are about the same as with conventional methods. One way to economize would be the introduction of radiation sterilization into the normal production process. (auth)

13550 RADIATION FACILITIES IN RELATION TO BIOLOGY AND AGRICULTURE. N. S. Rao (Atomic Energy Establishment, Trombay, India). p.411-26 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Biology research in progress at the Atomic Energy Establishment, Trombay is described. Studies are being made of the relative biological efficiency of ionizing radiation, radiosensitivity, mutation breeding in rice and groundnut, combined effects of radiation and chemicals, effects of neutrons in the first generation, insect sterilization and food preservation studies, and use of radioisotopes in biology and agriculture. (M.C.G.)

13551 USE OF THE RESEARCH REACTOR FOR BIOLOGY; SOME OPERATIONAL CONSIDERATIONS. S. Shapiro (Univ. of Oregon, Eugene). p.427-38 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Problems and considerations in the use of reactors in biology research are discussed. Reasons for using neutrons in biological experiments are outlined. (M.C.G.)

13552 PHOTOELECTRIC MEASUREMENTS OF SURFACE EFFECTS AFTER FRACTIONATED IRRADIATION WITH FAST ELECTRONS. M. Iffland. Thesis, Giessen, Ger., Universität, Giessen, 1963. 30p. $2.00(Gmelin, AED-DISS. 63-137). (In German)

Erythema on the tails of 180 rats after fractionated irradiation with fast electrons was measured using photoelectric methods. The results indicate that erythema effects are small for highly fractionated irradiations with long time intervals. (Gmelin Inst.)

13553 A COMPARISON BETWEEN THE EFFECTS OF FRACTIONATED ELECTRON AND X IRRADIATIONS ON INDUCED TUMORS. H. Rieger. Thesis, Giessen Ger., Universität, Giessen, 1963. 48p. $2.00(Gmelin, AED-DISS. 63-135). (In German)

The development of tumors induced in the tails of female white mice after single and fractionated irradiation with electrons and x rays was studied. Total dose was 5000 r for x rays and 8000 rem for Sr^{90} electrons. Increased fractionation resulted in a decreased effect for both electrons and x rays. Considering the healing of the tumors, the fractionation factor is larger for electrons than for x rays. (Gmelin Inst.)

13554 THE INFLUENCE OF GROWTH, AGING IN VITRO, AND HIGH DOSE X IRRADIATION ON THE NUCLEUS SIZE OF ASCITES TUMOR CELLS. U. van Lessen. Thesis, Bonn, Universität, Bonn, 1963. 41p. $2.00(Gmelin, AED-DISS. 63-134). (In German)

Measurements of nucleus size of MCa1 Ascites tumor cells gave an asymmetric normal distribution for sizes between 22.5 and 180 μ^2. About 1% of the cells had nucleus sizes between 250 and 450 μ^2. During growth and aging

nucleus size increased between the 5th and 17th day continuously. The number of large nuclei remained constant. X irradiation in vitro with 500, 2000, and 20,000 r resulted in an increase of nucleus size during the first 2 hours after irradiation. (Gmelin Inst.)

13555 RADIATION INDUCED VITALITY REDUCTION OF EHRLICH ASCITES TUMOR CELLS AS A FUNCTION OF OXYGEN PRESSURE. P. Kwadzo Ansah. Thesis, Hamburg, Universität, Hamburg, 1962. 32p. $2.00 (Gmelin, AED-DISS. 62-622). (In German)

The mortality of mice after intraperitoneal injection of diluted irradiated ascites tumor cells was studied. The cells were irradiated with 1000 r either in pure oxygen or pure nitrogen. 61% of the first group, 4% of the second, and 1% of the controls survived 20 days after injection. Possible mechanisms are discussed. (Gmelin Inst.)

13556 STUDIES OF MICROCOLONIES OF SALMONELLA TYPHIMURIUM INDUCED BY X-RAYS. H. Weber. Thesis, Munich, Universität, Munich, 1962. 80p. $2.00 (Gmelin, AED-DISS. 62-621). (In German)

Salmonella typhimurium (0.6×10^8 germs/cm^3) were irradiated with 75,000 r soft x rays. The number of surviving germs decreased to 6×10^3/cm^3. After irradiation 0.6% appeared as microcolonies with sizes between 0.15 and 0.45 mm. Most microcolonies were observed after 24 hr, some as late as 5 days. No morphological differences in comparison to normal colonies could be detected. It was concluded that the microcolonies are not mutations but temporary modifications. (Gmelin Inst.)

13557 STUDIES OF THE ACTION OF RADIOACTIVE PHOSPHORUS ON TUBERCULOSIS BACTERIA. B. Loerbroks. Thesis, Berlin, Universität, Berlin, 1961. 90p. $2.00(Gmelin, AED-DISS. 61-358). (In German)

Growth of colonies of tuberculosis bacteria in a medium containing 10–100 μC/ml P^{32} was studied. The lowest concentration resulting in a growth inhibition was 40 μC/ml. Catalase activity was not influenced by P^{32}. No chemosensibility was observed. Results of measurements of P^{32} retention are given. (Gmelin Inst.)

13558 STERILIZATION BY GAMMA-RADIATION OF THE SODIUM SALT OF p-AMINO-SALICYLIC ACID. B. Bellion, E. Denti, and A. Massaglia (SORIN, Saluggia, Italy). p.109-20 of "Industrial Uses of Large Radiation Sources. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In Italian)

Sodium p-amino-salicylate cannot be sterilized thermally. During manufacture or packing for medical purposes it must therefore be handled under sterilized conditions, with all the difficulties that this involves. Experimental data are presented that show that, using gamma irradiation, the product may be sterilized without damage and without the formation of substances harmful from the medical standpoint. (auth)

13559 IRRADIATION PLANT ECONOMICS. B. D. Baines (Nuclear Chemical Plant Ltd., London). p.243-64 of "Industrial Uses of Large Radiation Sources. Vol. II." Vienna, International Atomic Energy Agency, 1963.

A gamma irradiation plant designed specifically for the sterilization of sutures became operational early in 1963, after loading with 40,000 curies of Co^{60}. The plant capacity was determined using "Perspex" dosimeters with target material of constant density. The information obtained was used to determine cost data for irradiation treatment of materials over a wide range of densities for plants of similar design. Cost data were evaluated for plants where the number of passes are increased from four to eight or twelve. Such units are particularly suited to low target density materials where the throughput is high. Details of plant designs and costs are given so that operating cost data can be evaluated for other conditions. (auth)

13560 INDUSTRIAL STERILIZATION AT THE ELECTRON LINEAR-ACCELERATOR FACILITY AT RISØ. A. Brynjólfsson, N. W. Holm, G. Thårup, and K. Sehested (Danish Atomic Energy Commission, Risø, Denmark). p.281-95 of "Industrial Uses of Large Radiation Sources. Vol. II." Vienna, International Atomic Energy Agency, 1963.

The high dose rates obtainable from high power accelerators are valuable for fundamental chemical and physical research work, and also offer the possibility of performing pilot-plant operation prior to industrial application. The linear accelerator at Risø was used for such purposes, including irradiation of disposable medical supplies for industrial firms on a contract base. This linear accelerator yields a stable 10-Mev electron beam with an average power of five kilowatts. The beam can be directed through a straight-ahead window or through a beam bending and scanning device. The bent and scanned beam is employed for process irradiation. The packages to be irradiated are moved through the irradiation field by means of a conveyor system, which has available a full range of velocities from 0.2 to 600 mm/s, thus giving a wide dose range for a fixed accelerator adjustment. The facility began operation in the autumn of 1960 for Danish research institutions and in 1961 industrial radiation sterilization of disposable medical supplies, e.g., syringes, catheters, transfusion and infusion sets, and lung-heart machines, was begun. The processing rate increased steadily, the number of packages treated during the first 3 months of 1963 was about 3000. Each package may contain, say, 900 2-ml syringes. Work was carried out on the refinement of irradiation techniques, including application of reflector systems, automatic dose regulation, routine dosimetry, and visual color indicators. A survey of these details is given, and the actual sterilization processing, including handling, control and dosimetry, is described. Some information about the operating cost is given. (auth)

Radiation Effects Therapy and Countermeasures

13561 (AD-407579) PROSPECTIVE ANTIRADIATION AGENTS. Annual Progress Report, April 1, 1962–March 31, 1963. Gardner W. Stacy (Washington State Univ., Pullman). Contract DA 49 193md2049. 11p.

The five-step synthesis of 3-amino-2-methyl-2-butanethiol hydrochloride is described. An investigation of possible reaction of acetylene with 1-carbethoxy-3-pyrrolidone was pursued with the hope of forming an intermediate acetylenic carbinol which would ultimately lead to an aminothiol wherein the amino group would be part of the heterocyclic five-membered ring. The possibilities of forming aminothiols from aminoalkenes formed from Schiff bases was also investigated, but unfortunately, these intermediates failed to react with thiols to produce the described sulfide. The synthesis of aminoalkanethiols was also described. (auth)

13562 (AMRL-TDR-63-28) EFFECTS OF ANTIOXIDANTS ON RESISTANCE TO RADIATION INJURY. B. H. Ershoff and G. S. Bajwa (Western Biological Labs.,

Culver City, Calif.). Mar. 1963. Contract AF33(657)-8401. 25p. (AD-410008)

Since BHT (butylated hydroxytoluene) and certain other antioxidants significantly prolonged the average survival time of mice exposed to multiple sublethal doses of total body x irradiation, experiments were undertaken to determine the effects of antioxidants of diverse structure and activity and antioxidant synergists on length of survival following continuous exposure to a lethal dose of total-body γ radiation in the rat. BHT when fed at a 0.5% level in a purified diet and ascorbic acid at a 0.1% level significantly increased the average survival time of irradiated rats over that of rats fed the unsupplemented purified diet. Polygard (tri(nonylated phenyl)phosphites) when fed at levels of 0.25% and 0.5% and citric acid and phosphoric acid at levels of 0.1% in the purified diet also appeared to have some activity in this regard. Other antioxidants tested had little if any protective effect. The average survival time of irradiated rats was significantly longer for rats fed a natural food stock ration than for those fed the basal purified diet. No correlation was observed between the weight increment, organ weights, or microscopic appearance of the tissues of irradiated rats with length of survival on any of the diets employed. (auth)

13563 (TID-20236) AN INVESTIGATION INTO THE PHARMACOLOGICAL PROPERTIES OF ANTI-IRRADIATION DRUGS. Progress Report. REDUCTION OF DIMETHYLSULFOXIDE TO DIMETHYLSULFIDE IN THE CAT. Victor F. DiStefano (Rochester, N. Y. Univ.). Feb. 10, 1964. Contract AT(30-1)-2192. 21p.

Progress is reported in studies on the pharmacological properties of aminoethylisothiuronium bromide hydrobromide (AET) and dimethyl sulfoxide (DMSO) in mice and cats. The mechanisms of action of these radioprotective compounds were studied in an attempt to reduce their toxic effects when given to higher animals. Data are presented on the effects of AET on the central nervous system and the effects of DMSO on blood pressure, heart, respiration, gut mobility, and nervous system in the test animals. (C.H.)

13564 (JPRS-23559(Del.)(p.43-4)) USE OF DIAZOLIN UNDER CONDITIONS OF EXPERIMENTAL ACUTE RADIATION SICKNESS. S. A. Davydova and E. N. Shcherbova. Translated from Patol. Fiziol. i Eksperim. Terapiya, [7]: No. 6, 72(1963).

Therapeutic effectiveness of diazolin in acute radiation sickness was tested in 24 dogs irradiated with 300 rad of Co^{60} gamma rays. Diazolin was administered to 14 dogs in daily oral doses for 20 days or until the animals died. Some of the 14 were given additionally a complex of medicinal agents including antibiotics, vitamins, and securinin. The use of diazolin alone aggravated the course of radiation damage. Dogs receiving diazolin plus the therapeutic complex lived an average of 2½ days longer than the controls. Thus under the conditions used diazolin is considered ineffective in treating acute radiation sickness. (H.M.G.)

13565 RADIOPROTECTIVE ACTION OF SODIUM γ-HYDROXYBUTYRATE. M. Dana, C. Baron, and H. Laborit (Hôpital Boucicaut, Paris). Agressologie, 3: 497-506(1962). (In French)

The pharmacology of 4-hydroxybutyrate is briefly reviewed. The present study was carried out with female mice; 1 g/kg 4-hydroxybutyrate was injected intraperitoneally in a dose of 0.5 ml containing nine parts of the Na salt per 1,000, in most cases ½ to 1 hr before irradiation. LD_{100} for control animals was about 875 r; for those treated with 4-hydroxybutyrate, about 1100 r, both at 30 days. LD_{50} at 30 days was 750 r and 900 r respectively. The first set of figures is tentative. A similar dose given three hr before irradiation or immediately after irradiation does not appear to diminish mortality. The drug induces narcosis at this level. A dose of 250 mg/kg prevents the latter effect, but the radioprotective action is much less (on a small sample). Other materials containing hydroxyl functions were tested but none was effective; the present drug is not so effective as AET and appears to diminish its radioprotective effect. Butyrolactone has a similar action to that of 4-hydroxybutyrate; other anesthetics do not. Several suggestions are proposed to explain the narcotic effect. 4-Hydroxybutyrate may stimulate the pentose-phospate pathway, inducing sleep and perhaps arresting the chain of peroxidation reactions. Alternately it may enter into the γ-aminobutyric acid cycle. The drug does not have the toxic effect of AET. Its value appears to be its usefulness in prolonged radiodiagnostic procedures involving anesthesia; it serves then as an anesthetic and diminishes the effect of radiation dose to some extent. (BBB)

13566 EFFECT OF 2-β-AMINOETHYLISOTHIOUREA (AET) AND OF 5-HYDROXYTRYPTAMINE (SEROTONINE) ON THE SMALL INTESTINE AND THE HEMATOPOIETIC SYSTEM OF THE IRRADIATED MOUSE. J. B. Maisin, A. Léonard, M. Lambiet, and G. Mattelin (Centre d'Etude de l'Energie Nucléaire, Mol, France). Compt. Rend. Soc. Biol., 157: 1525-9(1963). (In French)

The results are reported from studies made to determine if the survival of mice exposed to a combined AET–serotonine treatment is higher than that of mice treated only by one of these two products and to confirm that the combined treatment offers, with respect to AET alone, a better protection to the hematopoietic system without improving the protection to the small intestine. Male mice, 3 months old, were exposed to 900, 1350, 1800, and 2250 r. Injections of the AET and serotonine were made before the irradiation. It was shown that combined treatment with AET and serotonine does not increase the intestinal protection of the mice exposed to 1350 r over that of mice protected with AET alone. But the combined treatment does give a better protection to the bone marrow and spleen. (J.S.R.)

13567 COMPARATIVE STUDY IN THE MOUSE OF THE RADIOPROTECTIVE EFFECTS OF SOME CATIONS. A. Cier, J. Tine, and C. Nofre (Centre de Recherches du Service de Santé des Armées, Lyon). Compt. Rend. Soc. Biol., 157: 1596-9(1963). (In French)

The radioprotective effects of Ni^{2+}, K^{+}, Sn^{4+}, Cr^{3+}, VO^{2+}, In^{3+}, Cd^{2+}, Sr^{2+}, Pt^{4+}, La^{3+}, Ba^{2+}, H^{+}, Pd^{2+}, Na^{+}, Ag^{+}, Fe^{2+}, Li^{+}, Ir^{4+}, Pb^{2+}, Zn^{2+}, Sc^{3+}, Cs^{+}, Ga^{3+}, Cu^{2+}, Fe^{3+}, UO_2^{2+}, Y^{3+}, Tl^{+}, NH_4^{+}, Au^{3+}, ZrO^{2+}, Co^{2+}, Ca^{2+}, Mg^{2+}, Mn^{2+}, Sn^{2+}, Al^{3+}, Hg^{2+}, Be^{2+}, Rb^{+}, Th^{4+}, and Ce^{3+} and the (ethylenediamine)tetraacetic acid chelates of Cu, Co, Cr, Ni, Mn, Hg, Zn, Cd, Al, Ca, and Fe^{2+} and Fe^{3+} were studied in male Swiss Albinos weighing 21 ± 2 g. The mice were exposed to 343 rads of gamma radiation 15 to 20 min after injection of aqueous solutions of the cations. The results show that ten elements (Ni, K, Sn(IV), Cr, V, In, Cd, Sr, Pt, and La) can be considered as radioprotectors if the analysis proposed by Gart is used. None of the chelates, except perhaps Cr and Cu, seemed to have any radioprotective power. The radioprotective effects do not appear to be connected to any particular physiochemical characteristics. (J.S.R.)

13568 ION INTERACTIONS IN THE RADIOMIMETIC EFFECTS OF ETHYL METHANESULFONATE (EMS) ON THE CHROMOSOMES OF VICIA FABA. Jean Moutschen-Dahmen and Madeleine Moutschen-Dahmen (Université, Liege and Université, Stockholm). Radiation Botany, 3: 297-310(Dec. 1963). (In French)

After treatments of dry broad bean and barley seeds with ethyl methanesulfonate (EMS) and examination of the first mitosis following germination, this compound was found to be practically without activity on chromosomes. When several salts were added, especially copper and zinc sulphates, a high rate of chromosome aberrations appeared. After eliminating a possible activity of SO_4^{2-} anion, Cu^{2+} was found to be more efficient than Zn^{2+}. The optimum of efficiency was observed for Cu^{2+} at pH 7.8 and for Zn^{2+} at pH 7.2. The activity of Cu^{2+} was shown when added before or during the treatments but when this ion was added just after treatments, the activity disappeared. In these experimental conditions, the observed effects were proportional to the dose of EMS. The induced aberrations were mainly of the chromatid class and generally the same as those found with other mesyloxyalkane compounds specially for their localization in heterochromatic segments of the genome. (auth)

13569 INEFFICIENCY OF TREATMENT WITH BATYL ALCOHOL ON THE SURVIVAL OF MICE EXPOSED TO LETHAL X-RAY DOSES. P. Bassi and A. Dunjic (Università, Louvain, Belg. and Università, Parma, Italy). Radiobiol. Latina, 6: 99-103(Jan.-Mar. 1963). (In Italian)

Batyl alcohol given every second day at a dosage of 0.25 mg up to a total dosage of 1.75 mg fails to improve the survival rate of mice irradiated with 600, 650, and 700 r of x radiation. This study confirms the negative results already obtained in rats. (auth)

13570 THE USE OF HEMATOGENIC MARROW IN THE COMPLEX THERAPY OF RADIATION SICKNESS. I. Piesca and D. Stanescu. Rev. Sanit. Mil., 59: 739-48 (Sept.-Oct. 1963).

The complex clinical manifestations of acute radiation sickness and the importance of adapting therapy to the specific conditions of the individual clinical case are discussed. It is pointed out that at present bone marrow transfusions are appropriate for lethal radiation cases, and that they may be combined with other methods for the treatment of all cases of radiation sickness. (TCO)

13571 CLINICAL EXPERIENCES WITH THE ENZYME INHIBITOR POLYPHLOROGLUCINEPHOSPHATE IN GYNECOLOGIC PROBLEMS. W. Michalica and E. Picha (Universitäts-Frauenklinik, Vienna). Wien. Med. Wochschr., 113: 178-80(Feb. 23, 1963). (In German)

In the treatment of wounds, including those from radiation injury, various antibiotics are generally used. One fat-free ointment contains 1% polyphloroglucinephosphate in a polyethylene glycol base; it inhibits bacterial invasion by inactivating hyaluronidase. This enzyme hydrolyzes and depolymerizes the mucopolysaccharide hyaluronic acid which is found in the intercellular components of mesenchyme. The inhibition of hyaluronidase activity in the mesenchyme results in reduced permeability of connective tissue, thus limiting exudation and inflammation. The ointment has also an antiedemic effect, similar to that of corticosteroids. Reports by various authors on the physiological effects of the ointment are discussed. Since the growth and reproduction of bacteria is inhibited by the withdrawal of nourishment from hydrolyzed tissue products, rather than by an antibacterial effect, no allergic reactions, tissue incompatibility, bacterial resistance, nor diminishing effectiveness were observed even after prolonged and repeated application. Treatment of two groups of gynecologic disorders with the ointment are reported. One group had various infections and the other were treated for infected lesions of the vagina and uterine cervix resulting from radium implantations for gynecologic cancer. In all cases the suppurating process was terminated shortly after application of the ointment and the clearing of the wound area followed rapidly. No undesirable side effects were observed. (BBB)

13572 EFFECTS AFTER IRRADIATION OF FEMALE GENITAL NEOPLASM. R. Dippon. Thesis, Tuebingen, Ger., Universität, 1962. 74p. $2.00(Gmelin, AED-DISS. 62-624). (In German)

The treatment of carcinomas of female genitals is reviewed. Secondary diseases are discussed in respect to possible surgical interventions. Results of treatment of 94 patients are given. (Gmelin Inst.)

13573 RADIATION PROTECTION IN MAMMALS. John F. Thomson. New York, Reinhold Publishing Corporation, 1962. 218p. $8.50.

Progress in the study of several groups of radioprotective compounds is reviewed, with particular emphasis on the sulfur derivatives such as the thiol groups. Studies presented are restricted to problems of prevention and treatment of damage caused by external irradiation of mammals. The most commonly used sources of external radiation are neutrons, x rays, and gamma rays. Basic principles of interaction between radiations and living matter are reviewed, providing a foundation for discussion of physiological effects of ionizing radiation. Methods for testing radioprotective agents, criteria of the ideal protective agent, and factors influencing the testing of protective agents are surveyed. Environmental modifications of radiation effects described are: partial body shielding, reduced oxygen tension, and reduced body temperature. Protective thiols (cysteine, cysteamine, AET); other sulfur compounds (thioureas, thiouracils, dithiocarbamates, dithiooxamides, etc.); pharmacologic agents (anesthetics, hypnotics, sedatives, alcohols, analgesics, tranquilizers, histamine, serotonin, etc.); metabolic inhibitors (cyanide and nitrides); metabolites; inorganic compounds such as deuterium; phenols; and amines are evaluated. Mechanisms of protective action are considered for prophylactic agents generally with illustrative use being made of specific compounds. Once an organism has been exposed to radiation, methods other than chemical protection must be employed. Postirradiation treatment techniques are briefly reviewed, and it is concluded that the administration of isologous bone marrow is by far the most effective. (H.M.G.)

Radiation Hazards and Protection

13574 RADIATION HAZARD TO PATIENTS. K. A. Rowley (Victoria Hospital, Blackpool, Eng.). Brit. Med. J., 2: 1001(Oct. 19, 1963).

Recent United Kingdom surveys assessing patient exposure in diagnostic radiology and the responsibilities of radiologists in reducing such exposure are briefly discussed. (BBB)

13575 ASSESSMENT OF THE RADIATION DOSE TO CANADIANS FROM FALLOUT. W. E. Grummitt and J. E. Guthrie (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 42: 287-91(Feb. 1964). (AECL-1873)

Sr^{89}, Sr^{90}, Cs^{137}, and plutonium in precipitation collected at Deep River, Ontario, were measured for the 10-year period ending December, 1962. The accumulated deposit, in mc/km^2, amounted to 34 mc of Sr^{90}, 53 mc of Cs^{137}, and 0.5 mc of plutonium. The mean concentration of Sr^{90} in rain (and snow) for the same period was 4.2 pc/l. Using these results, the 30-year infinite plane γ-dose from fallout deposited prior to 1963 was calculated to be 27 mrem. It is shown that this calculation applies to all of southern Canada. (auth)

13576 STUDIES ON DOSE RATES DUE TO SCATTERED GAMMA-RAYS. L. Bozóky (Central Inst. for Oncology, Budapest). Kernenergie, 7: 22-5(Jan. 1964). (In German)

For Co^{60} gamma radiation the fundamental relation between dose rate of the scattered radiation and incidence angle, scattering direction, and density and material of the scattering medium were investigated experimentally. From the measurement results the dose factor, with which the dose rate of the scattered radiation can be easily calculated, was obtained for concrete and lead. (tr-auth)

13577 THE EFFECT OF GELATIN CONTAINING FREE SH-GROUPS (THIOGEL) ON THE RADIO-INJURED SMALL INTESTINE OF THE RAT. Johannes Pany (Universität, Vienna). Naturwissenschaften, 50: 734-5(1963). (In German)

The protective effects of thiogel and AET on mice of both sexes exposed to 1050 and 1400 r were compared. At intervals of 24, 48, 72, 96, and 144 hrs. after irradiation, the DNA concentration of the mucosa and the specific activity of isolated H^3-labeled DNA were determined. The results are tabulated, and a significant protective effect was shown for the thiogel. However, the protective effect is limited to the mucosa. (J.S.R.)

13578 X-RAY HAZARD FROM ELECTRON MICROSCOPES. V. A. Phillips and J. A. Hugo (General Electric Research Lab., Schenectady, N. Y.). Science, 143: 1120-1(Mar. 13, 1964).

The observation of x-ray emission from electron microscopes, which persisted for long periods, is reported. One incident occurred when oil vapor was drawn from the diffusion pump into the column because of failure of a sealing ring in the column. For a week or two after this occurrence, continuous x-ray emission was observed in an upward direction from the base of the gun whenever 100 kv was applied, accompanied by a gun-current reading due to the ion current. A second x-ray emission at 100 kv is also described. It is noted that additional lead glass protection was found desirable over the viewing window of the particular instrument when lining up the column with 100 kv applied and the condenser aperture removed, because of x-ray emission from the screen. (P.C.H.)

Radiotherapy and Radiodiagnosis

Refer also to abstract 13650.

13579 (JPRS-23317) SOVIET DIAGNOSTIC RADIOLOGY. A Survey of the Published Literature, 1959-1963. Victor Dukoff. Feb. 20, 1964. 68p. (OTS-64-21611)

Recent advances in equipment and procedures for diagnostic radiography are surveyed. (C.H.)

13580 THE USE OF HIGH ENERGY PROTONS FOR CEREBRAL SURGERY IN MAN. Borje Larsson, Lars Leksell, and Bror Rexed (Uppsala Univ.). Acta Chir. Scand., 125: 1-7(Jan.-Feb. 1963).

Exploratory studies in three patients using the 185-Mev proton beam of the 230-cm Uppsala synchrocyclotron for localized irradiation of brain lesions are reported. Such a narrow beam of ionizing radiation may be used to transect intracerebral fiber tracts and to destroy discrete deep-seated volumes of brain tissue. With this technique it is not necessary to open the skull, and bleeding and infection are thereby avoided. Such stereotaxic radiosurgery of the brain might be useful as a supplement to conventional techniques for localized tissue destruction. Since 1958, the 185-Mev proton beam has been used on a small group of patients, and the results of the first three operations performed one to three years ago are reported. One patient had a psychic disorder, another pain due to cancer metastases, and the third Parkinsonism. Preliminary measurements indicated that irradiation of small, restricted regions in the brain could be done with more precision by using the high-energy part of the course of penetration of the 185-Mev protons rather than by the use of the Bragg peak of the depth-dose curve. Therefore, the same cross-fire techniques as described earlier in the previous experiments on goats was used. Thus, the protons entered the patient's skull at almost full energy in a parallel, 2- or 3-mm wide beam, practically unaffected by scattering in the window, air, and ionization chamber through which they passed after leaving the vacuum of the synchrocyclotron. Cross-firing was performed by stepwise rotation of the patient, the target region being at the rotation center of the stereotaxic instrument through 16 to 21 fields giving doses of 16 to 25 krad at this point. The ionization chamber used was calibrated in terms of ideal center dose by measuring the C^{11} activity induced in small polystyrene cylinders, 1 mm in diameter, irradiated at the rotation center. The irradiation parameters are tabulated. The stereotaxic instrument used supported the patient's head during irradiation is described. Using local anesthesia the instrument was fixed to the skull by means of drills which penetrated a few millimeters into the bone. The target structure was localized in relation to reference points visible on the pneumoencephalogram of the patient by comparison with a template, prepared from a standard ventriculogram from a cadaver brain. Only the patient with Parkinsonism was irradiated under general anesthesia. Therapeutically effective lesions were produced during the first weeks following irradiation. No side effects due to the radiosurgical procedure were observed. The patient with the carcinoma died and the lesion found at autopsy was studied histopathologically. The early radiosurgical lesion in man was found to be similar to lesions studied earlier in animals. (BBB)

13581 THE APPLICATION OF RADIOISOTOPES IN MEDICINE. Ludwig Heilmeyer. Assoc. Belge Develop. Pacifique Energie At., Bull. Inform., 8: Nos. 45-46, 68-75(Oct. 1963). (In French)

The scope of the utilization of radioisotopes in medicine is indicated by the presentation of several examples. The examples cited are detection of pernicious anemia, diagnosis of blood diseases involving lack of iron, treatment of red polycythemia, and treatment of thyroid malfunction. (J.S.R.)

13582 DETECTION OF INCOMPLETE ABLATION AFTER YTTRIUM-90 IMPLANTATION OF PITUITARY. J. G. Sprunt, A. C. Brownie, and J. S. Kinnear (Queen's Coll., Dundee, Scotland). Brit. Med. J., 2: 1375-8(Nov. 30, 1963).

A new method is described for evaluating the effectiveness of Y^{90} irradiation of the pituitary to eliminate its secretory activity. Metyrapone is injected and urinary ex-

cretion of 17-hydroxycorticosteroids is measured. Nine out of 17 patients implanted with 9 mC Y^{90} showed residual hypophyseal endocrine activity on the basis of this test. (BBB)

13583 ON THE X-RAY-DIAGNOSIS RADIATION BURDEN TO CHILDREN IN HOSPITALS AND OUTPATIENT DEPARTMENTS. R. Pape, J. Zakovsky, and A. Harasta (Wilhelminenspitals, Vienna). Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 100: 100-13(Jan. 1964). (In German)

The individual doses received by children in the course of x-ray diagnostics were measured at four hospitals and one large outpatients' department. At none of these examinations did the regional doses produce any hazard to the body. In the examination of regions away from the gonads such as the extremities and on the chest the gonad doses were of the order of one thousandth of the incident dose. With an appropriate technique those doses can be kept at the level of the natural background dose which accumulates over a few hours or days. With less frequent examinations of the abdomen and the femur the gonad dose was higher by two to three orders but also here reduction of dose is possible by using gonad shields and by reducing screening dose (approximately 0.25 ma and shortening the time). When the irradiated area was carefully restricted, the small dimensions of the child's body proved to be advantageous in so far as the required incident dose was always smaller than for an adult. In this respect the baby offered the most favorable dose conditions. When gonad shields were used, the doses could then be kept as low as the order of the natural background dose accumulating over a few days. The differences that were established between various departments originated chiefly from the radiography of extremities, head, and chest producing a low radiation level. A simple way is described for estimating the order of diagnostic doses. (auth)

13584 RADIOACTIVE ISOTOPES IN MEDICAL PRACTICE. Joseph Selman (Mother Frances Hospital, Tyler, Tex.). Hosp. Progr., 43: 105-12(Oct. 1962).

Some of the more pertinent elementary physics of radioisotopes, as a background for establishing a small or basic radioisotope department, are reviewed. Material in the medical literature on various aspects of this subject is discussed and a list of references is appended. Radioisotope instrumentation is described, including specifications and applications of the Geiger-Mueller tube, sintillation detectors, scalers, and ratemeters. Counting errors and efficiency are explained, and examples of technical problems encountered are illustrated by reference to I^{131} thyroid uptake studies. (BBB)

13585 A PRELIMINARY CLINICAL REPORT CONCERNING OXYGEN BAROTHERAPY AND MEGAVOLTAGE RADIOTHERAPY. J. P. Madigan (Peter MacCallum Clinic, Melbourne). J. Coll. Radiol. Australasia, 6: 94-101(Dec. 1962).

Attempts were made to develop a radiotherapy technique to increase the sensitivity of various types of tumors by exposing the patient to oxygen at high pressure in a specially constructed chamber while undergoing high-voltage x-ray treatment. Results are reported for 110 cases of locally advanced malignant tumors in various sites that have received treatment combining oxygen barotherapy with 4-Mev x-ray therapy, delivering three large fractions of x-ray dosage in a total time of 21 days. Each patient received general anesthesia, bilateral myringotomy, and pressurization of oxygen to 45 lb/in.^{2} gauge pressure in a pressure vessel. Cases treated during the first 10 months are reported in relation to their status from 2 months after treatment. Immediate tumor resolution was good but severe radiation reactions required reduction of the dosage first used. Reduction of the dose to 3 × 1000-rad maximum tumor dose did not significantly alter the sequelae and more recently a maximum tumor dose of 3 × 800 rad was used. The reduced dosage was well tolerated, being no worse than that expected when conventional techniques were used to deliver 6000 to 6500-rad tumor doses in 5 to 6 weeks with 4-Mev x rays. The higher doses in oxygen showed mucosal reactions similar to those seen at the site of a radon implant producing 6000 to 7000-rad tumor doses in 5 to 7 days but of course involved much larger volumes of tissue. Experience with similar large doses delivered in air, compared with those used with barotherapy, suggests that dose for dose the mucosal reactions were more intense with barotherapy. Animal lab studies lended support to this conclusion. Skin reactions, on the other hand, seemed to parallel the dosage received on the skin and not to be aggravated by oxygenation effects. Tumor resolution with the various dosage schemes employed was very satisfactory and often dramatic. Delayed necroses appeared commonly five months after completing treatment in those cases treated with high doses who developed the most intense mucous membrane reactions even though healing was almost complete 2 to 3 months after treatment. The use of antibiotics, corticosteroids, and triiodothyronine did not influence progression. Definite local recurrence of tumor within the treated volume was confirmed in only a few cases. In three patients, comparison was possible of the tumor resolution produced by the barotherapy technique with the resolution produced when similar dosage was given in air to a regional metastasis later appearing. The resolution was far superior with barotherapy. Bilateral myringotomy produced temporary deafness, usually unilateral, in approximately 20% of the cases, and only four patients have any residual deafness. It is concluded that the pressure vessel allows treatment of advanced tumors in practically all sites without seriously limiting the application of x-ray fields which would be normally chosen with conventional megavoltage therapy. In the 110 cases local tumor disappearance was noted in 60% to 80%, depending on whether an optimistic or pessimistic view was taken of those cases with still uncertain status. (BBB)

13586 PHYSICAL CONSIDERATIONS OF TREATMENT PLANNING. K. H. Clarke and K. L. Biggs (Cancer Inst., Melbourne). J. Coll. Radiol. Australasia, 6: 103-5(Dec. 1962).

A discussion is presented of the special problems encountered in the use of a pressure vessel in oxygen barotherapy which are not encountered in ordinary megavoltage treatments. The pressure vessel is constructed of a light alloy, with Perspex portals through which the x-ray beams can be directed. It was designed specifically for use with the Metropolitan Vickers Linear Accelerator. The longitudinal axis of the pressure vessel must always lie perpendicular to the plane of rotation of the accelerator x-ray beam; this means that all x-ray fields must be in a transverse plane. In selecting the field distribution, the angles have to be chosen so that the x-ray beams avoid the metal members between adjacent Perspex portals. All treatments are planned for a focus-tumor distance of 100 cm, so that when the tumor is positioned at the isocenter of the linear accelerator, all fields pass through the tumor whatever the angulation of the beam. Shielding has been found necessary in many cases to provide odd-shaped fields giving protection to eyes, spinal cord, or other vital structures. For this, a special shielding device was designed which fits

into the end of the accelerator housing. The device is a Perspex plate with radial slots which open out to a larger diameter near the periphery for loading shielding blocks. The distance between the Perspex shielding plate and the end of the accelerator head is only 2.9 cm. Since the shielding device could not be allowed to protrude beyond the end of the accelerator head, the shielding blocks had to be made of a high density material and a readily available Cu–W alloy was chosen; 2.9 cm of this alloy permits the transmission of only 8% of the direct 4-Mev x-ray beam. The presence of a Perspex portal in proximity to the skin results in a loss of the so-called skin-sparing effect of m megavoltage x radiation. Secondary electrons from the Perspex span the gap between the Perspex and the skin and raise the skin dose, the increase depending upon how close the Perspex is to the skin. The effect of the proximity of the Perspex on the skin dose was determined over a full range of field sizes and a full range of Perspex-skin distances. Considering a field size of 100 cm^2, the normal skin dose of 19% of peak dose is raised to 27, 40, 59, and 85% for Perspex-skin distances of 20, 15, 10, and 5 cm, respectively, and this factor has to be taken into account when determining skin dose in oxygen barotherapy. Since treatment in the pressure vessel generally results in Perspex-skin distances of 15 to 10 cm, the skin dose for a 100-cm^2 field will be between 40 and 59% of peak dose and the dose at ½-mm depth, which may be responsible for skin reaction, will be between 63 and 76% of peak dose. (BBB)

13587 CLINICAL ASPECTS OF TREATMENT PLANNING IN BAROTHERAPY. R. C. Kerr (Peter MacCallum Clinic, Melbourne). J. Coll. Radiol. Australasia, 6: 106-10(Dec. 1962).

The technique of barotherapy, the irradiation treatment of patients within a pressure vessel breathing oxygen under pressure during the x-ray treatment, is described. Initially, the radiation dose consisted of three fractions of 1000 rad minute tumor dose (min TD) given on days 0, 7, and 21, except for cerebral tumors, which received two fractions of 1000 rad min TD on days 0 and 7. More recently the dose has been reduced to three fractions of 800 rad on days 0, 7, and 21. It is stressed that this dose and fractionation represents radical local radiotherapy with curative intent and therefore treatment volumes must be limited to prevent local tissue tolerance or patient tolerance being exceeded. An arbitrary upper limit in treatment volume of 10 × 10 × 10 cm or its equivalent was used. The patient is anesthetized, an endotracheal tube passed, and a bilateral myringotomy is performed. Compression in the chamber is then commenced, the rate of compression used being 5 psi/min, taking approximately 9 min to compress up to 45 psi, gage pressure (4 atm). During this time the patient's position is checked in the pressurized vessel and any slight adjustments of longitudinal, lateral, or vertical positions are made under pressure. The patient is kept at 45 psi for 10 minutes before commencing treatment to ensure better oxygenation of the tumor. X-ray treatment times range from 8 to 25 min, depending on the number of fields and whether wedge filters are used. ECG, respiration, and other bioelectric information are monitored throughout treatment. (BBB)

13588 LATE RESULTS OF I^{131} TREATMENT OF HYPERTHYROIDISM IN SEVENTY-THREE CHILDREN AND ADOLESCENTS. Paul Starr, Henry L. Jaffe, and Leon Oettinger, Jr. (Los Angeles County Hospital; Univ. of Southern California, Los Angeles; and Cedars of Lebanon Hospital, Los Angeles). J. Nucl. Med., 5: 81-9 (Feb. 1964).

Seventy-three children and adolescents ranging in age from 28 months to 18 years were treated with radioiodine for hyperthyroidism. Hypothyroidism is known to have developed some time after therapy in 43 of the 71 living cases, and only 12 others maintained normal thyroid capacity without exogenous thyroid hormone. A nodule was found after therapy in five cases; one girl, on whom a subtotal thyroidectomy was performed before the first isotope therapy was completed, was found to have a hot nodule seven and one half years post-surgery; a second dose of 10 McI^{131} was given, with regression of the nodule and thyrotoxicosis. A nodule, in one case, remaining after shrinkage of a large gland by I^{131} treatment was diagnosed at the time of surgery 2 years and 3 months after isotope administration as papillary adenocarcinoma. It has not recurred in the 5½ years since this surgery. Neither of the two deaths which occurred in less than one year after treatment is attributable to the I^{131} therapy. Three children were subjected to subtotal thyroidectomy after incomplete I^{131} treatment; one of these died of surgical shock. Hyperthyroidism was controlled in all the cases adequately treated, even though repeated administration was required in some cases. The growth and development of these patients, particularly those less than 11 years of age, was normal. A total of 31 healthy normal children has been born to 20 of the adolescents reported in this series. No abnormal children were produced, although one pregnancy (of the wife of one of our patients) if completed, would have resulted in Siamese twins. There were no deaths attributable to the I^{131} treatment of hyperthyroidism; nor is there any evidence of parathyroid gland deficiency, laryngeal cord paralysis, or blood dyscrasia, and there is no case, including the malignant nodule found in one case, of thyroid cancer that is attributable to this internal radiation therapy. (auth)

13589 AGE DIFFERENCES IN ROUTINE SCANS OF HUMAN BRAIN WITH ARSENIC-74. John R. Whittier (Creedmoor Inst. for Psychobiologic Studies, New York), Lillian E. Jacobson, and Andreas Dhrymiotis. J. Nucl. Med., 5: 134-8(Feb. 1964).

Print counts were made over a frontal area of the head on records obtained during positron scanning with arsenic 74 in 29 patients. Counts were significantly higher ($p < 0.001$) for 12 patients aged 60 and over in a group of 26 without recognized disease of liver or kidney. Highest counts were obtained in two patients with cirrhosis of the liver. Possible explanations for the finding are discussed, including differences in extracerebral tissue mass, cerebral parenchymal volume, blood volume, total extra-cellular fluid cerebral volume, and clearance capability by liver and kidney. It is concluded that impaired clearance capability probably underlies the difference, and that this factor should be controlled if isotopes are employed to study cerebral blood flow or metabolism. (auth)

13590 TREATMENT OF CHRONIC LEUKEMIAS. Edwin E. Osgood (Univ. of Oregon, Portland). J. Nucl. Med., 5: 139-53(Feb. 1964). (TID-19742)

Results of treatment of 212 chronic lymphocytic leukemias and 114 chronic granulocytic leukemias with the method of titrated, regularly-spaced total-body irradiation are presented, with data on survival time, comparative effectiveness of P^{32} and x ray, radiobiologic observations, complications of the disease and therapy, and prognostic factors. The reason why this group of patients had a better survival than any other published series of leukemias treated by other methods is now apparent in the light of my unifying concept of the fundamental nature of malignancies. The action of ionizing

radiation is to decrease the rate of cell division and thus to decrease the risk of further genetic change to a still shorter life span of the involved somatic n cell. In other words, the ionizing radiation substitutes for the alpha-2 alpha and alpha-n division inhibitors. The effect on cell division does have a threshold. The roentgen equivalent man for either cells of the lymphocytic series or granulocytic series of 1.0 mc of P^{32} intravenously in the adult equals about 15 r of total body irradiation. The important variable influencing prognosis appears to be age and sex, with the female patients and the younger patients doing far better than the male patients and the patients over 61 at onset of the disease. The common complications and their treatment are outlined. (auth)

13591 ETIOLOGY OF LEUKEMIAS. W. M. Court Brown, Isbbel M. Tough, and Patricia A. Jacobs (Western General Hospital, Edinburgh). Lancet, 2: 198(July 27, 1963).

The criticisms advanced by Schöyer against the proposed etiologic relation between diagnostic irradiation and leukemia are answered, with emphasis on the classification of leukemias according to types. (BBB)

13592 ACUTE LEUKEMIA FOLLOWING ADMINISTRATION OF RADIOIODINE FOR THYROTOXICOSIS. John A. Thomson (Royal Infirmary, Glasgow). Lancet, 2: 978-9(Nov. 9, 1963).

Development of leukemia in a 40-yr-old woman treated with I^{131} is reported, as well as the results of chromosome studies to investigate the possible etiologic role of radiation. A small nodular goiter was found initially and the clinical diagnosis of thyrotoxicosis was confirmed by radioiodine studies (24-hr uptake of I^{131} = 72% dose; 48-hr protein-bound I^{131} = 1.47% dose/l plasma). She was given a therapeutic dose of 10 mC I^{131} and her condition improved greatly. Eight months later she became hypothyroid and was given thyroxine. She responded satisfactorily to this and was stabilized on a dose of 0.25 mg daily. Acute leukemia was diagnosed 18 months after I^{131} therapy and death followed a month later. Chromosome studies, carried out on the marrow cells, gave completely normal results, suggesting that radiation may not have been the cause of the leukemia. A review of reports of leukemia following radioiodine therapy for thyrotoxicosis shows only 18 cases, of which 3 were from Great Britain. Thus the frequency of leukemia in general was no higher in the patients treated with radioiodine for thyrotoxicosis than in the control population, but the incidence of acute leukemia (13 out of 17 where the type of leukemia was known) was higher than expected. The present case was also acute, but the chromosomal analysis supports the view that the radioiodine therapy was not the cause of the subsequent leukemia. Another report shows that five out of seven patients with acute leukemia after therapeutic irradiation had definite chromosomal abnormalities and slight changes were present in the other two patients. In contrast, of 15 patients with acute leukemia who had not been exposed to radiation, chromosomal abnormalities were found in only three. (BBB)

13593 ACTIVE CONTAMINATION OF Y^{90} RADIOISOTOPE. Daniel Voedroes ([Municipal Public Health and Communicable Diseases Station], Budapest). Magy. Radiol., 14: 358-60(Dec. 1962). (In Hungarian)

When a Y^{90} preparation used for radiotherapy was examined for purity by measuring its half life, a foreign source of radiation was discovered. Thus a γ-emitting source was detected, in addition to the pure β emission expected for Y^{90}. It was also found that the contaminating element had a half life of 75 days. Subsequent measurements showed the material to emit ~0.5-Mev γ radiation identical to that of Ir^{192}. Since Ir^{192} contamination of the Y^{90} isotope during manufacture and preparation was ruled out, there remained the possibility that the inactive Y starting material contained Ir originally. It was assumed that this trace of Ir became active at the time of irradiation in the reactor; however, the Ir activity represents only a minute portion of the Y activity at the time of preparation and shipment. After 75 days the Y with a half life 28 times shorter that of Ir^{192} is almost completely disintegrated, whereas the Ir^{192} isotope has been reduced to only half its initial activity. This means that in 1 C of Y^{90} there remains perhaps a few thousandths of a μC, whereas the original 1 μC of Ir^{192} still contains 0.5 μC active Ir. This contaminating isotope can be removed from the Y^{90} only at a great cost. It is suggested that consideration should be given to how much this contamination hinders the effectiveness of the radioisotope for therapeutic purposes. (BBB)

13594 THE EMPLOYMENT OF X-RAY THERAPY IN THE ACUTE PERIOD OF BURN AFFECTION. I. B. Gurevich and R. I. Murazyan. Med. Radiol., 9: 20-4(Jan. 1964). (In Russian)

Roentgen rays were used in the treatment of 70 patients with burns during the first 24 hours. Favorable results were achieved in patients with 2nd-3rd degree burns involving 5-20% of body surface: subsidence of pain, diminution of edema and plasmorrhea. Roentgen therapy yielded the best results in irradiation of the face. No complications associated with x-ray therapy were observed. (auth)

13595 DETERMINATION OF THE MEAN RADIATION ENERGY WITH THE AID OF A PROPORTIONAL COUNTER. A. N. Denisenko and V. K. Lyapidevskii. Med. Radiol., 9: 65-8(Jan. 1964). (In Russian)

A method of determining the mean energy of nonmonochromatic radiation by the number of pulses N per unit of time and total current I on the output side of the proportional detector is described. By taking the proportion I/N obtained with the aid of a scintillation counter, the mean energy of gamma radiation coming from different sources was determined. (auth)

13596 SOME POSSIBILITIES OF NEUTRON RADIOGRAPHY. J. P. Barton (Univ. of Birmingham, Eng.). Phys. Med. Biol., 9: 33-42(Jan. 1964).

The feasibility of using a beam of neutrons for medical radiography or biological research is considered. The chief advantage of neutrons over x rays is seen to be the new possibility of studying the uptake of many isotopes of high neutron-absorption cross sections. Thicknesses of up to about 3 cm of either tissue or bone might be radiographed with thermal neutrons, the limiting thickness being determined by the harmful effects of radiation to living tissue. For the penetration of greater thicknesses the use of epithermal neutrons is suggested, and particular advantages are foreseen for the use of monoenergetic neutron beams of resonance energies. (auth)

13597 CARCINOMA OF THE THYROID GLAND WITH METASTATIC QUADRIPARESIS; TREATMENT WITH RADIOIODINE AND ITS COMPLICATIONS. Israel Zivin and Simon Zivin (Northwestern Univ., Chicago). Quart. Bull. Northwestern Univ. Med. School, 36: 60-3(1962).

The case presented illustrates the dramatic effects of I^{131} therapy on carcinoma of the thyroid gland with metastases to the cervical spine and the quadriparesis which developed secondarily to the metastases, and also the complications that are attendant on therapeutic radioiodine

administration. The case was initially treated with roentgen therapy and then radioiodine to inhibit the metastatic spread of the carcinoma and to reduce the pressure effects of the osseous metastases on the spinal cord. However, the hematologic aspects of the therapy proved to be more serious than the original cord compression syndrome, and were more resistant to therapy. When the 50-yr-old patient was admitted to the hospital, a radioiodine uptake study revealed him to be euthyroid; the uptake was 15.1%. A biopsy of the thyroid mass was performed and histologically proven to be an undifferentiated carcinoma. A skeletal survey also revealed a mass in the 5th lumbar vertebra, which was interpreted as a metastatic lesion. The patient was given a course of deep x-ray therapy to the neck and cervical spine; a second course of irradiation was administered one month later. Pursuant to this therapy, there was a mild regression in the quadriparesis, but roentgenograms of the cervical spine revealed progressive destruction of the 7th cervical vertebra. He then received an intensive course of radioiodine (total dosage was 788.7 mC). Within a period of three months following this therapy, there was a complete regression of the quadriparesis; the neurologic findings, including the hypesthesia, had returned to normal. The patient was able to return to his previous occupation, but after an interval of two years he experienced progressive weakness and dyspnea. Inspection revealed an acutely ill, markedly anemic patient. A hemogram revealed a red blood cell count of 1,500,000, hemoglobin of 5.2 g, and white blood cell count of 1100 per mm^3. A sternal bone marrow examination revealed severe hypoplasia with depression of all elements. The patient continued to experience recurrent episodes of moderate to severe anemia, and hemograms showed progressively increasing white cell count, with an increased percentage of blast cells. Before death the hemogram revealed a white blood cell count of 33,400 with 78% blast cells. This course was consistent with an acute myelocytic leukemia. The leukemia was resistant to all therapeutic agents, including steroids and Purinthal; the patient was sustained on repeated whole blood transfusions. The time interval between radioiodine therapy and the detection of the leukemia in this case was ~21 months. Whether isotope therapy predisposed the patient to the subsequent development of lymphomatous disease or whether such a development was coincidental and independent of any such therapy was discussed. (BBB)

13598 POSSIBILITIES OF AN INDEPENDENT CIRCUIT X-RAY APPARATUS GIVING LOW RADIATION EXPOSURES TO PATIENTS. O. Hubacher (Roentgeninstitut, Thun, Switzerland). Radiol. Clin., 32: 437-51(1963). (In German)

A new portable x-ray device, capable of operating on a storage battery and affording reduced doses during radiographic examinations, is described. The primary current is modulated to a high-voltage transformer at a prescribed frequency through a special converter. The device can be used continuously, when the batteries (standard 12-v truck battery) are either connected to a main current source or recharged by a standard automobile generator system. Without charging, more than 1000 radiographs can be made. Some of the characteristics of the new system are: the kv peak used being kept constant, it is possible to obtain from the battery-operated generator radiographs which are comparable photographically with those obtained from single- or 3-phase conventional generators, with a much lower ma-sec value. At equal photographic clarity, the radiation dose to the patient is very much reduced with respect to x-ray devices utilizing single phase or 3-phase generators. This pronounced reduction in patient dose is attributed to two causes: the greater depth dose, reaching film, accounts to a large extent for the total dose reduction; the frequency curves show a special photochemical effect, the heavy film blackening is partly produced by this effect. Attention is drawn to the main advantage of an equipment, which, being battery-fed, can be operated anywhere independently of a conventional electric power supply. The other advantages of the new generator were demonstrated with film-blackening tests and dosimetric data. (BBB)

13599 RADIORESISTANT AND RECURRENT EPITHELIOMAS: RADIOTHERAPY WITH A RADIOSENSITIZER (SODIUM CYCLOHEXYLSUCCINATE). E. G. Scolari, M. Nanneli, and C. Vallecchi (Università, Florence). Rass. Dermatol. Sifilog., 14: 295-303(Nov.-Dec. 1961). (In Italian)

By the use of sodium cyclohexylsuccinate, a substance possessing high radiosensitizing activity, it was possible to reirradiate refractory tumors with successful results. A group of 28 patients suffering from recurring epithelial skin tumors, which showed little radiosensitivity following an initial radiation treatment, was selected. In these patients the identical radiological treatment which had been administered initially was repeated. To allow comparative evaluation, control measures ensured that: the recurring epithelioma had dimensions ~ the same as that of the primary epithelioma; side-effects complicating the recurring tumor, such as necrotic suppurative phenomena, were absent; a localization that would avoid the risk of radionecrosis following a second radiation treatment; finally, and most important, a sufficiently long time elapsed between the two treatments. Among the epitheliomas treated were some that had remained almost unchanged following initial therapy. Patients received 2 g cyclohexylsuccinate daily for 9 to 10 days while undergoing irradiation. Results showed a 78% tumor-eradication rate, which is high in comparison with that of relapsing epitheliomas treated by other methods. It was concluded that the biologic action of radiation was reinforced by the use of cyclohexylsuccinate. An x-ray treatment, in itself ineffective or only palliative, became effective in a large percentage of cases. (BBB)

13600 THE USE OF IODINE-125 AS A DIAGNOSTIC AGENT IN OPHTHALMOLOGY. Frank W. Newell, Seymour B. Goren, Herbert E. Brizel, and Paul V. Harper (Argonne Cancer Research Hospital, Chicago). Trans. Am. Acad. Ophthalmol. Otolaryngol., 67: 177-86(Mar.-Apr. 1963).

The use of radioactive isotopes in ophthalmology has been restricted by the physical properties of the radioactive compounds available. Beta-emitting compounds, such as radiophosphorus (P^{32}), are mainly useful in abnormalities of the anterior ocular segment. Gamma-emitting compounds are of value only if significant quantities are retained by ocular tissue, with the remainder being rapidly excreted. Under these conditions, the radioactive target within the eye would not be obscured by surrounding radiation, particularly that emanating from the intracranial circulation. Although P^{32} has often been useful in the diagnosis of anterior segment neoplasms, its application to posterior segment and orbital tumors has been disappointing. Subconjunctival dissection, rotation of the globe, and curved probes sometimes allow counting over the lesion but often do not. The probe used to measure the radioactivity must be in close proximity to the neoplasm. The test has proved to be of no value in the differential diagnosis of retinoblastoma. Its accuracy is reduced in the presence of active ocular inflammatory disease, following

ocular surgery, and in one-eyed patients. Characteristics favorable to clinical use of radioisotopes are listed. Iodine-125 in most of these respects qualifies as an excellent isotope for ocular use. It may be substituted advantageously for P^{32} or I^{131} in many clinical and experimental situations in ophthalmology. The use of diiodofluorescein labeled with I^{125} for detection of intraocular tumors is described; the procedure for its use is given in detail; and results in 39 patients are revealed. In the 19 patients with histologic evidence of neoplasm the test was correctly positive in 15 and a false negative result occurred in 4, an overall accuracy of 79%. In 20 patients with a variety of non-neoplastic ocular diseases there were no positive tests. Successful results are also reported on the efficacy of I^{125}-labeled diiodofluorescein as a diagnostic agent in the laboratory, the V-2 rabbit carcinoma being used as an experimental model. Clinical results of tests using I^{125}-labeled tetracycline are also described. (BBB)

13601 STRONTIUM-90 (YTTRIUM 90) IN PTERYGIUM SURGERY. Ogden D. Pinkerton. Trans. Pacific Coast Oto-Ophthalmol. Soc., 43: 121-7(1962).

Preparation of Sr^{90} and applicators for it, and its successful use in eye disorders are discussed. Irradiation with Sr^{90} has proved invaluable in the treatment of pterygia when combined with surgical therapy. The preliminary surgical and Sr^{90} application techniques are described in detail. The Sr applicator does not have special curved openings in order to assure diffuse delivery of radiation to the limbus area. It is difficult enough to apply it to the whole area accurately without confining the access of the β rays. The cornea, being an avascular collagenous tissue, is tolerant or resistant to radiation. The sclera, although less tolerant, can easily stand more than 2000 rep, and it is suggested that benefit from Sr^{90} used in this way is not due to its effect on new capillaries but lies in creating a hyalinized area in the limbal sclera, an area that provides an adverse surface into which capillaries do not invade. They often regrow around the edge of the treated area or through an area that was inadvertently missed due to inaccuracy in placing the applicator. It is necessary, therefore, to create this new or changed tissue as early as possible and this is the reason for removing capillaries by leaving 3 to 4 mm of bare sclera and for the use of Sr^{90} immediately following surgery. Results in 220 patients treated with doses of Sr^{90} radiation varying from 1500 to 7000 rep are reviewed. It is concluded that the use of Sr^{90} has markedly improved the prognosis in the surgical treatment of pterygia, when bare sclera is left to remove capillaries and radiation therapy is immediately applied to hasten the creation of an unfavorable tissue to capillary invasion. This optimal dosage of 2000 rep is safe, and lens changes are not expected to occur; however, there seems to be a rather wide variation in the tolerance to Sr^{90} in different individuals. (BBB)

CHEMISTRY

General

13602 (BM-RI-6303) ELECTRODEPOSITION STUDIES OF MOLYBDENUM, TUNGSTEN, AND VANADIUM IN ORGANIC SOLVENTS. Robert E. Meredith and Thomas T. Campbell (Bureau of Mines, Albany Metallurgy Research Center, Ore.). Nov. 1962. 17p.

An investigation was undertaken to examine the feasibility of employing low-temperature nonaqueous baths for electrodepositing some of the refractory metals of the ferroalloy group. Deposition studies were performed in a wide variety of organic solvents, including amides, ammonia derivatives, ketones, polyhydroxy alcohols, and ethers. Compounds prepared and used as solutes included the chloride and bromide salts of vanadium, tungsten, and molybdenum. Studies were conducted over a temperature range of 20 to 200°C under inert atmosphere. Conductivity and current potential data were obtained for all baths that contained reasonable solute concentrations. Qualitative solubility data were obtained for compounds of ferroalloy metals in a variety of solvents. In general, all solutes showed low solubility in ethers and ketones but reasonable solubility (in excess of 20 g/l) in alcohols, amides, and ammonia derivatives. No successful metallic deposits that would encourage further study were obtained with any of the systems that were examined. (auth)

13603 (K-1303) DENSITY, SOLUBILITY, AND PHASE RELATIONS OF THE SYSTEM URANIUM HEXAFLUORIDE-2,2,3-TRICHLOROHEPTAFLUOROBUTANE. W. C. Kuykendall, C. G. Jones, Karl E. Rapp, and E. J. Barber (Oak Ridge Gaseous Diffusion Plant, Tenn.). Feb. 13, 1957. Contract W-7405-eng-26. 18p.

The experimental solid-liquid equilibrium values for the system uranium hexafluoride–2,2,3-trichloroheptafluorobutane were measured, the liquid-vapor equilibria were calculated at total pressures of 30 and 40 psia, and experimental solution densities were determined. The liquid density for all compositions which form true solutions over the temperature range of 21 to 84°C is given by the equation $\ln \rho = \alpha(m) + \beta(m)\,X$ where ρ = density, g/cc, m = mole per cent uranium hexafluoride, $\alpha(m) = 0.12698 + 3.73352 \times 10^{-3}m + 1.95458 \times 10^{-6}m^2$, $\beta(m) = 0.12603 + 7.40421 \times 10^{-4}m$, $X = 10^3/T$, and T = temperature, °K. The maximum error in the density obtained by use of the equation is ±0.34% at the 95% confidence level. The agreement between the experimental and theoretical solubilities is good, the maximum absolute error being less than 2.5 mole per cent. The solutions exhibit a small positive deviation from Raoult's law. The calculated liquid-vapor equilibria are probably accurate enough to be used in engineering design without increasing the allowances made for normal experimental and design effects. (auth)

13604 (MITS-51) ADAPTATION OF NEW RESEARCH TECHNIQUES TO MINERAL ENGINEERING PROBLEMS. (Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy). Oct. 31, 1963. Contract AT(30-1)-956. 28p. (NYO-10330)

Brief summaries are presented of the following projects (some of which are still in progress): electrochemical study of the ferric oxide-solution interface, contact angle hysteresis in the dodecane–water–quartz–amine system, adsorption in the hematite–water–diisobutyl ketone system, gas-phase conditioning for flotation of a non-metallic ore, contact angle hysteresis in the dodecane–water–quartz–dodecyl ammonium chloride system, particle size determination by combined centrifugation and gamma emission, mixed adsorption from the gaseous phase to ferric oxide, electrochemical study at the zinc oxide solution interface, beryl flotation, flotation of a phosphate ore from South Africa, contact angle hysteresis in the galena–aqueous potassium ethyl xanthate–nitrogen system, and relationship between rheological properties and thickening mechanism. (D.L.C.)

13605 (TID-20204) PHOTOCHEMICAL REACTIONS OF COMPLEX MOLECULES IN CONDENSED PHASE. Progress Report, May 1, 1963–April 30, 1964. Henry Linschitz (Brandeis Univ., Waltham, Mass.). May 1, 1957. Contract AT(30-1)-2003. 15p.

Research continued during the period on energy dissipation mechanisms following light absorption, on the chemistry of excited molecules (including redox and ionization processes), and on complex ion equilibria. New developments or findings during the period include the demonstration of a new tunneling reaction resulting in the elimination of H from diphenylamines to form carbazoles. The detailed mechanism of the reaction, requiring nine rate constants, was quantitatively established, using a combination of quantum-yield and flash-photolysis techniques. Further evidence is presented indicating a charge-transfer mechanism for the quenching of excited aromatic molecules by transition metal complexes. The order of quenching appears to correspond to the "nephelauxetic series," for both singlet and triplet excited states. Evidence is also presented for penta-covalent Fe (III) complexes, in non-aqueous solvents. The characteristic spectrum of tetra-chloroferrate ion is not found in certain Fe (III) complexes in basic media, although the requisite number of chlorides are present. Measurements of reaction kinetics of radical-ions in symmetrical photo-redox systems were made, and clarification of differences between photooxidation and photoreduction mechanisms was achieved. Also, observation of light-induced transformations among species found in alkali-metal-amine solutions was made. (auth)

13606 (TID-20241) COORDINATING SOLVENTS. (Illinois. Univ., Urbana). [1964]. Contract AT(11-1)-758. 73p.

The self-ionization and coordination models of organic solvent-inorganic solute interactions are compared for $FeCl_3$ in $POCl_3$ and $PO(OEt)_3$. The coordination model is shown to be the best one for describing nonaqueous solvent chemistry, and general concepts of this model are considered. Methods for establishing coordination and determining the solution species are discussed. The energetics of solvent-solute interactions are described, and solute behavior in a series of typical coordinating solvents are discussed. Generalization of the results are considered. (D.L.C.)

13607 APPLICATIONS OF NEUTRON DIFFRACTION IN CHEMISTRY. G. E. Bacon. The International Encyclopedia of Physical Chemistry and Chemical Physics. Topic 11. The Ideal Crystalline State. Volume 1. A Pergamon Press Book. New York, The Macmillan Company, 1963.

Information is included on: principles and methods; hydrogen bonds in inorganic compounds; organic compounds; heavy element compounds of C, N, and O; metal hydrides and ammonium compounds; compounds that in-

clude neighboring elements; magnetic materials; and liquids and gases. (P.C.H.)

Analytical Procedures

Refer also to abstract 14160.

13608 (AERE-R-4510) THE DETERMINATION OF PLUTONIUM-241 IN RESIDUE SOLUTIONS BY NEUTRON ACTIVATION. G. W. C. Milner and A. J. Wood (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1964. 9p.

A neutron activation method is described for the determination of low concentrations (micrograms per ml) of plutonium-241 in residue solutions resulting from the chemical processing of electromagnetically separated plutonium isotopes. This method is based on the large cross section (1010 barns) for the thermal fission of plutonium-241. It involves the irradiation of a small volume of sample solution in nitric acid, simultaneously with a similar volume of a standard solution of plutonium-241 with the same isotopic composition as the plutonium in the sample. All solutions are sealed in silica before irradiation for 3 hours in Bepo, and then they are allowed to cool for a few days before examination by γ-spectrometry. Peaks due to the Ba^{140}/La^{140} system with energies of 0.33, 0.49, and 1.60 Mev, respectively, are evaluated to obtain the plutonium-241 content of each sample. This method depends on plutonium being the only fissionable material in the sample, but it is applicable to solutions containing many non-fissionable elements. (auth)

13609 (ANL-6769(p.117-26)) A RAPID SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF LEAD IN BONE ASH. F. H. Ilcewicz, Richard B. Holtzman, and H. F. Lucas, Jr. (Argonne National Lab., Ill.).

A rapid and accurate procedure for the analysis of microgram amounts of lead in concentrated calcium phosphate or bone ash solutions (up to about 0.2 g/ml) and an effective means of eliminating possible interferences are described. Measurements were made on spectrophotometers. The bone ash was dissolved in 9M HCl and the solution was extracted 3 times with 20% triisooctylamine (TIA). The standard error was 2.0%. The standard deviation was ±0.12 μg Pb/ml. (M.C.G.)

13610 (BM-RI-6308) DETERMINATION OF COBALT AND NICKEL IN TUNGSTEN BY A COMBINED ION EXCHANGE X-RAY SPECTROGRAPHIC METHOD. E. F. Spano, T. E. Green, and W. J. Campbell (Bureau of Mines. College Park Metallurgy Research Center, Md.). Jan. 1963. 21p.

A combined ion-exchange–X-ray spectrographic method was developed and evaluated for determining trace amounts of cobalt and nickel in high-purity tungsten and tungsten trioxide. The sensitivity for both cobalt and nickel is in the range from 0.2 to 0.5 μg (0.04 to 0.1 ppm, based on 5 gram samples). Accuracy at the 5 to 20 μg level is ±10 percent of the amount present. Approximately 16 hours elapsed time are required for analysis. (auth)

13611 (CEA-2301) ANALYSE ISOTOPIQUE PAR SPECTROSCOPIE OPTIQUE. (Isotopic Analysis Using Optical Spectroscopy). S. Gerstenkorn (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 37p.

The isotopic displacement in the atomic lines of certain elements (H, He, Li, Ne, Sr, Hg, Pb, U, Pu) is used for dosing these elements isotopically. The use of the Fabry-Perot photo-electric interference spectrometer is shown to be particularly adapted for this sort of problem: in each case the essential results obtained with this apparatus, and the results previously obtained with a conventional apparatus (grating, photographic plate) are given. These results together give an idea of the possibilities of optical spectroscopy: in the best case, the precision which may be expected is of the order of 1 to 2 per cent for isotopes whose concentration is about 1 per cent. (auth)

13612 (CEA-2369) DISPOSITIF DE PRELEVEMENT DE SODIUM SUR UN CIRCUIT EN VUE DU DOSAGE DES IMPURETES. (Device for Sampling Sodium from a Circuit with a View to Measuring its Impurities). J. Sannier and R. Vingot (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 6p.

The sampling device described was developed with the two following essential conditions in mind: absence of any pollution during the sampling operation and the transfer to the analysis apparatus and simultaneous extraction of several samples, each one remaining representative of the sodium in the circuit. The sampling is therefore carried out completely in a vacuum in a Pyrex apparatus, this limits the sodium temperature to a maximum of 240°C. The samples are in the form of bulbs sealed in vacuo containing 2 to 3 grams of sodium each. The determination of the oxygen content by the amalgamation technique, carried out on samples obtained by this method, showed a very satisfactory reproducibility for concentrations of under 20 ppm. (auth)

13613 (CONF-285-7) THE ANALYSIS OF TOTAL BERYLLIUM IN BERYLLIUM METAL BY GAMMA ACTIVATION. Harry L. Rook (Mound Lab., Miamisburg, Ohio). [1963]. Contract [AT(11-1)-705]. 12p.

From 7th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 1963.

A rapid and precise method was developed for both the destructive and nondestructive radioanalysis of total beryllium in beryllium metal. The gamma-neutron (γ,n) reaction in beryllium was used because of its low, 1.63 Mev, threshold energy which eliminates interference from all other elements. Indium foil was used as the neutron detector to eliminate interference from the high level gamma field associated with the neutron production. Each method required three hours to complete and had a relative error of ±0.4% at the 95% confidence level. (auth)

13614 (CONF-313-2) THE APPLICATION OF NUCLEAR TECHNIQUES IN COAL ANALYSIS. Interim Technical Report No. 2, May 1, 1962–July 31, 1963. (Texas Nuclear Corp., Austin, Tex.). Oct. 24, 1963. Contract AT(40-1)-2980. 108p.

From 2nd National Meeting of the Society for Applied Spectroscopy, San Diego, Calif., Oct. 1963.

The results of a feasibility study on the utilization of nuclear techniques in coal analysis have shown that the carbon, oxygen, aluminum, and silicon content can be accurately determined. The accuracy with which these four elements can be measured is in the range of from 1 to 3% under laboratory conditions. These results also indicate that to measure any of the other minor elements present in coal to the same degree of precision would be difficult and radio-chemical separation techniques would also be necessary. The utilization of the nuclear techniques investigated in this study, fast neutron inelastic scattering and fast neutron activation analysis, will have to depend upon the use of empirical relationships connecting the element or ele-

ments measured with the desired parameters. Measurements indicate that Btu and ash content may be empirically determined for coal from a particular mine through measurements by nuclear means. (auth)

13615 (CONF-433-1) MODERN SOLID STATE MASS SPECTROSCOPY AS A TOOL FOR STANDARDIZATION IN ANALYSIS OF NUCLEAR MATERIALS. T. Leo Collins, Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 19, 1963. Contract W-31-109-eng-52. 17p.

From American Society Testing Materials, Philadelphia, Feb. 1963.

A discussion is presented of the role mass spectrometry can play in meeting the rigid demands imposed by materials people on manufacturers and analytical chemists. Examples of the application of mass spectrometers to materials research are given. (auth)

13616 (DP-543) SPECTROPHOTOMETRIC DETERMINATION OF MIXTURES OF NEPTUNIUM(IV) AND NEPTUNIUM(V) IN NITRIC ACID SOLUTIONS. E. K. Dukes and W. E. Shuler (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Dec. 1960. Contract AT(07-2)-1. 8p.

The absorption spectra of Np(IV), Np(V), and Np(VI) were measured in 1M HNO_3 and a spectrophotometric method of analysis was devised for mixtures of Np(IV) and Np(V) in nitric acid solution. In the analysis, the absorption of Np(IV) was measured at the sharp absorption band at about 715 mμ and the absorption of Np(V) was measured at 617 mμ. A novel adaptation of a Beckman DU spectrophotometer permitted the neptunium solutions to be confined in a gloved box so that the instrument was not exposed to possible contamination by the alpha activity of Np^{237}. (auth)

13617 (EUR-478.f) LE DOSAGE DES TRACES MINERALES DANS LES POLYPHENYLES PAR SPECTROGRAPHIE X. (The Determination of Trace Amounts of Inorganic Compounds in Polyphenyls by X-Ray Spectrography). G. Vos (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 24p. (CONF-435-1)

From XXV Annual Congress of the Group for Advancement of Spectroscopic Methods, Paris, June 1963.

A large number of elements such as Zr, U, Fe, Cr, Ni, Mn, Co, Cu, Zn, Ca, S, P, and Cl can be determined in polyphenyls by x-ray spectrography. Detection limits extend from some tenth of ppm for the elements between Ca and U, up to some ppm for the lighter elements, i.e., P, S, and Cl. However, the use of new conditions of analysis ought to improve the latter values. (auth)

13618 (EUR-531.e) COMPUTER PROGRAM SYSTEM FOR A QUANTITATIVE ANALYSIS BY NEUTRON ACTIVATION AND GAMMA-RAY SPECTROMETRY. A. Borella and G. Guzzi (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy and European Atomic Energy Community. European Scientific Data Processing Center, Ispra, Italy). Feb. 1963. 55p.

A simple and flexible program, which allows a quantitative analysis of the gamma spectra of the radioisotopes used in the laboratory to determine the activity of some samples, is presented. The gamma spectra, punched on a high speed tape connected to the gamma spectrometer, are transferred to IBM cards by means of the digital computer IBM 1620. The calculations are then made by an IBM 7090 computer. The program, the write-out of data, and the results are included. (auth)

13619 (HW-66689) REACTOR EFFLUENT MONITORING DEVICES—AN INTERIM REPORT. C. A. Ratcliffe (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1960. Contract AT(45-1)-1350. 24p.

Proposed systems for relatively simple, reliable, digital monitors for Np^{239}, As^{76}, and Zn^{65} are presented. The control and counting components for a Np^{239} monitor were designed, assembled, and tested. It is shown how this system, or one similar, can be applied to monitors for As^{76} and Zn^{65}. Solid state electronic components were used wherever possible. The described Np^{239} monitor uses a liquid-liquid TTA extraction to obtain rapid, quantitative extraction of the Np^{239}. The organic phase is viewed with a NaI scintillation crystal-multiplier phototube detector, and the response recorded on a Hewlett-Packard digital printer. Circuits were designed for simplicity and reliability. A monitor is proposed for As^{76}. This instrument would continually monitor a stream for As^{76}, using a cation exchange column, a gamma ray spectrometer, and background correction to reduce interference. A monitor for Zn^{65} using a zinc amalgam chemical technique and gamma ray spectrometry is proposed and described. (auth)

13620 (HW-79738) TRILAURYLAMINE EXTRACTION: SPECTROGRAPHIC DETERMINATION OF TANTALUM IN PLUTONIUM. Roy Ko (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1963. Contract AT(45-1)-1350. 9p.

Ion exchange and tributylphosphate extraction separations of tantalum from plutonium were tried. A trilaurylamine extraction-spectrographic method for the determination of tantalum in plutonium was developed. Plutonium was dissolved in HCl and separated by amine extraction from the undissolved tantalum and from any tantalum that might have dissolved. HF was then added to dissolve all the tantalum and the solution was concentrated by evaporation. Niobium internal standard was added and tantalum determined in the aqueous phase by graphite spark spectrographic analysis. Concentrations of tantalum as low as 50 ppm in 50 mg of plutonium were determined with an estimated relative standard deviation of ±7%. (auth)

13621 (IDO-14613) MANUAL OF RADIOCHEMICAL METHODS. D. G. Olson, ed. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Jan. 3, 1964. Contract AT(10-1)-205. 86p.

The radiochemical methods used by the Analytical Branch, Atomic Energy Division of Phillips Petroleum Company for the determination of specific nuclides are described. Pertinent information on sample type, kind of separation, and time required for the determination are noted as headlines on each procedure. Some thirty-two methods are presented. (auth)

13622 (IS-825) TRICARBALLYLIC ACID (PROPANE-1,2,3-TRICARBOXYLIC ACID)—A NEW GRAVIMETRIC REAGENT FOR RARE EARTHS. A. K. Gupta and J. E. Powell (Ames Lab., Ames, Iowa). [Feb. 1964]. Contract [W-7405-eng-82]. 14p. (CONF-405-1)

For Presentation at the 4th Rare Earth Research Conference, Phoenix, Ariz., Apr. 1964.

The formation of rare-earth tricarballylates was studied. The heavy rare earths were found to form extremely insoluble compounds with a definite degree of hydration. The precipitation of heavy-rare-earth tricarballylates was best carried out using diammonium acid tricarballylate at pH 5.5 to 7.0. The gravimetric estimation of rare earths by the oxalate and tricarballylate methods was studied and compared, and it was found that the rare earths could be separated easily from Ca, Ba, Zn, and Na in the tricarballylate method. (D.L.C.)

13623 (K-1590) INSTRUMENTATION FOR MEASURING FREEZING POINTS OF URANIUM HEXAFLUORIDE–HYDROGEN FLUORIDE SAMPLES. M. J. Bartkus (Oak Ridge Gaseous Diffusion Plant, Tenn.). Mar. 12, 1964. Contract W-7405-eng-26. 14p.

Instrumentation to facilitate the semiautomatic measurement of the freezing points of samples of binary mixtures was developed and applied to the problem of determining the composition of uranium hexafluoride–hydrogen fluoride mixtures. Use of the instrumentation reduced the time required for analysis of uranium hexafluoride–hydrogen fluoride mixtures by a factor of five. The components used were commercially available or were alterations to commercially available devices. Variations of the described instrumentation could be applied to the general problem of measuring the percentage of soluble contaminants in a compound. (auth)

13624 (LA-3035) THE GRAVIMETRIC DETERMINATION OF TRACE AMOUNTS OF CARBON IN SODIUM METAL. Ross D. Gardner and William H. Ashley (Los Alamos Scientific Lab., N. Mex.). Jan. 1964. Contract W-7405-eng-36. 13p.

The classical combustion-gravimetric method for the determination of carbon was modified and applied to the measurement of trace amounts of carbon in sodium metal. The sample, contained in an aluminum capsule, was reacted with a flux consisting of a mixture of boric anhydride and vanadium pentoxide and burned in a stream of purified oxygen at 1100°C. An average recovery of 96% with a standard deviation of 10 ppm was obtained for the analysis of 40 samples containing known amounts of carbon in the 0 to 200 ppm range. (auth)

13625 (LAL-1053) MICROANALYSE PAR L'OBSERVATION DE REACTIONS NUCLEAIRES: APPLICATIONS A LA PHYSIQUE DU SOLIDE (THESE). (Microanalysis by the Observations of Nuclear Reactions: Application to Solid-State Physics (thesis)). Georges Amsel (Paris. Université, Orsay. École Normale Supérieure. Laboratoire de l'Accélerateur Lineaire). May 1963. 39p.

The classical methods of analysis using nuclear physics are tracer analysis and activation determinations. These are briefly described as an introduction to analytical methods using products of nuclear reactions. Analysis based on elastic scattering of charged particles, nuclear reactions whose cross section varies slowly with energy, and reactions whose cross section varies rapidly with energy is described. As examples, the microdetermination of oxygen with (d,α) and (p,α) reactions is described and discussed. The tracer study of the mechanism of anodic oxidation is also given as illustration. The energy loss by a particle beam passing through solids and the concentration after ionic transport in an oxide layer are calculated in the appendix. (J.S.R.)

13626 (NYO-10174) RESEARCH IN ACTIVATION ANALYSIS. Final Report, April 23, 1962–July 31, 1963. Henry H. Kramer, Victor J. Molinski, Roy S. Tilbury, Werner H. Wahl, and Paul M. Stier (Union Carbide Nuclear Co. Research Center, Tuxedo, N. Y.). Sept. 30, 1963. Contract AT(30-1)-2975. 102p.

Studies in the areas of rapid radiochemical separations of radioisotopes with short half lives and the production by neutron irradiation of short lived metastable isomeric states are described. The use of the isomers and the radiochemical process in activation analysis procedures are evaluated. Methods were developed and are described for the determination of Al, Ti, V, Nb, and Mo in ore and polyethylene samples. Metastable isomeric states of Ba^{137m}, Cd^{111m}, Se^{77m}, Sr^{87m}, Pb^{204m}, W^{185m}, Os^{190m}, Y^{89m}, and Hg^{197m} were evaluated as sensitive analytical indicators. A β-γ anticoincidence system was designed to permit the detection of gamma rays emitted in metastable isomer transitions with more favorable signal-to-noise ratios. (P.C.H.)

13627 (ORNL-3537) ANALYTICAL CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING NOVEMBER 15, 1963. (Oak Ridge National Lab., Tenn.). Feb. 18, 1964. Contract W-7405-eng-26. 162p.

Research and development progress is reported on analytical instrumentation, chemical analysis of advanced reactor fuels, analytical studies of molten-salt systems, special research problems, reactor projects, effects of radiation on analytical methods, x-ray and spectrochemical analyses, spectroscopy, optical and electron microscopy, nuclear and radiochemical analyses, inorganic preparations, organic preparations, and analytical development. Service analyses are also described. Separate abstracts were prepared for each topic. (M.C.G.)

For abstracts of individual chapters see: 13628, 13629, 13630, 13631, 13632, 13633, 13634, 13635, 13636, 13637, 13724, 13810, and 13837.

13628 (ORNL-3537(p.1-17)) ANALYTICAL INSTRUMENTATION. M. T. Kelley and D. J. Fisher (Oak Ridge National Lab., Tenn.).

Several instruments were modified for specialized applications. An ORNL model Q-1988 controlled-potential and derivative polarograph for molten-salt voltammetry and a model Q-1988A for use at fast scan rates with dropping-mercury electrodes having drop times of $\frac{1}{2}$ sec, or less were modified. A spectrophotometer was modified for continuous recording of the titration of free fluoride ion. The time per analysis was reduced from 75 to 15 min, and the precision of analysis was improved. For a fused salt application, the precision chronopotentiometer was altered to function with system ground isolated from earth ground. Also, an improved constant-current supply was incorporated in the modified instrument. Progress in controlled-potential coulometry was achieved with the fabrication of two ORNL model Q-2564 high-sensitivity coulometric titrators, and with revision to the method that describes the ORNL model Q-2005 electronic, controlled-potential coulometric titrator. A check-out and test procedure for the Q-2564 is being written. Development and improvement of apparatus for the remotely controlled analysis of highly radioactive samples, primarily those associated with the MSRE, was continued. The aligning, crushing, and powder-transfer devices are being used in the ORNL High-Radiation-Level Analytical Facility for the remotely controlled preparation of samples obtained from the Volatility Pilot Plant. A hot-cell exhaust filter assembly, which can be removed and replaced by the master-slave manipulators, was designed and installed in the hot cell of the Building 3038 Hot Laboratory. A d-c preamplifier and an a-c-to-d-c converter, both having high input impedance and providing buffering to the voltage source being measured, were designed for a digital voltmeter. The converter can serve as a standard for a-c voltage measurements because of its d-c calibration. The design, construction, and evaluation of the high-sensitivity, direct-reading, linear, recording, conductometric titrator was completed. A proportional temperature controller that provides essentially stepless control of titration cell temperature to within ±0.01°C was designed

to supplement the automatic temperature-compensation circuit for high-sensitivity work. The performance of the conductometric titrator on about forty different chemical systems met, or exceeded, design criteria. The controlled-potential a-c polarograph was rebuilt with a new potentiostat having improved performance characteristics. Test runs made with a D.M.E. on solutions that contained 10^{-4}M Cd^{2+} in 0.1M KCl showed that the instrument achieves excellent rejection of the double-layer charging current. Other tests indicated that excellent resolution of the In^{3+} and Cd^{2+} waves ($\Delta E_{\frac{1}{4}}$ = 38 mv) is obtained. A model VII high-resolution, flame spectrophotometer, which uses a single multiplier phototube to cover the entire wavelength range from 2000 to 8700 Å, was designed and put into service for emission photometry. Either instantaneous or integrated flame emission intensities can be recorded for measurement. The unit can also be used with an absorption source assembly for atomic absorption work. It was observed that it is necessary to limit the initial current delivered by the potentiostat in the controlled-potential coulometric titrations of any of several ionic species. The reason for a positive bias at high initial current (1 to 2% for uranium) is not known. A study to determine the cause of this error was initiated. In controlled-potential coulometry, the reference electrode may be placed arbitrarily in any position in the current density gradient present in the cell. One theory of electrochemical behavior suggests that when the reference electrode is placed in a region of low current density, an error in potential can exist in the reaction zone in the region of high current density. This error, conceivably, could cause the discharge of a second ion, and thereby contribute an error in analysis. A study to determine the importance of reference-electrode placement in controlled-potential coulometry was undertaken. No chemical evidence for the existence of a potential error, even under drastic cell conditions, was obtained. An investigation was completed of the feasibility of polarography for the direct determination of metal complexes in the organic phase following solvent extractions. A d-c polarograph was used to produce controlled-potential regular and first-derivative polarograms of cadmium and uranium in several solvent-extraction systems, including those of the ion-association and chelate types. The average-current and derivative computer circuits were modified to permit the use of a ½-sec, Smoler type, vertical-orifice D.M.E. and the use of scan rates up to 3 v/min. A quantitative method for the determination of microgram quantities of uranium in tri-n-octyl-phosphine oxide extract was developed. Polarography in the organic extracts from solvent extraction offers the following advantages: the substance to be determined can be concentrated selectively, matrix elements that interfere are removed, and a separate stripping step into an aqueous medium is not required. Also, the possibility exists of performing polarographic analysis on species unstable in water. The compensation of cell resistance by controlled-potential polarography was studied. It was found necessary to place the reference electrode within a distance of 0.1 r (where r is the radius of the drop) from the mercury drop in order to avoid distorted polarograms in solutions of high specific resistance. An electrode apparatus consisting of a sharpened, Smoler type, vertical-orifice, ½-sec D.M.E. and a reference electrode probe was constructed for this study. A controlled-potential voltammeter was designed and built for operation in molten-salt (including molten-fluoride) systems. The voltammeter design uses several operational amplifier modules to achieve the functions necessary. The cells, fabricated from graphite or metal, contain a stationary polarized electrode, a counter electrode, and a reference electrode and may have a variable, uncontrolled resistive leakage to earth ground. For the uninsulated cell vessels, system ground must float with respect to earth ground. Performance tests of this voltammeter are in progress. (auth)

13629 (ORNL-3537(p.17-23)) CHEMICAL ANALYSIS OF ADVANCED REACTOR FUELS. J. C. White, A. S. Meyer, and P. F. Thomason (Oak Ridge National Lab., Tenn.).

Studies in this program were concerned mainly with the controlled-potential coulometric titration of uranium in solutions of uranium-bearing fuels and on the determination of various reaction products resulting from the dissolution of uranium carbides and thorium carbides. A coulometric cell of 15-ml capacity was designed especially for use with the ORNL Q-2564 high-sensitivity, controlled-potential, coulometric titrator; uranium in the amounts of 2.5 and 48 μg in a total volume of 5 ml was determined with a relative standard deviation of 0.8 to 0.2%, respectively. A controlled-potential, coulometric method for the determination of uranium in sodium fluoride solutions was developed. At the 6-mg level, the relative standard deviation is 0.2%. Studies on the determination of carbon in aqueous and nitric acid solutions from the dissolution of carbide type fuels were continued. A gas chromatographic measurement of the CO_2 produced by oxidation of the carbon-containing compounds was incorporated into the procedure to effect an improvement in sensitivity of some twentyfold over the manometric measurement of CO_2. The interference of residual oxides of nitrogen was also eliminated by use of the gas chromatographic measurement. Gas chromatography was used to resolve and determine the products from the reaction of carbide fuels with CCl_4 in the presence of air. With a 15-ft silica-gel column, only Cl_2 and $COCl_2$ were not resolvable from the expected reaction-product mixture of air, CCl_4, CO, CO_2, and $COCl_2$. Silicone-gum-rubber columns of ~15-ft length appeared to offer complete resolution of these compounds. The oxides of nitrogen were determined gas chromatographically on a 3-ft long, 1-in.-ID, silica-gel column programmed from 25 to 300°C. The order of elution under these conditions is NO, N_2O, N_2O_4, and NO_2. Studies were initiated on the gas chromatographic determination of polynuclear aromatic hydrocarbons such as naphthalene, biphenyl, anthracene, and phenanthrene, which are expected to be formed when uranium carbide is heated in nitric acid and the resulting acids are decarboxylated at elevated temperatures. A mixture of di-sec-butylphenylphosphonate (2.5 vol %) and diethylbenzene (97.5 vol %) that was degraded with nitric acid was analyzed gas chromatographically with a Reoplex 40 column at 200°C. The isomers of diethylbenzene were measured on a 200-ft by 0.01-in. capillary column coated with di-n-decyl phthalate and operated at 110°C. (auth)

13630 (ORNL-3537(p.23-30)) ANALYTICAL STUDIES OF MOLTEN-SALT SYSTEMS. J. C. White (Oak Ridge National Lab., Tenn.).

Voltammetric studies in molten-fluoride salt systems were continued. The voltammetric behavior of Fe^{2+} in LiF–NaF–KF was determined, and the activation energy for the $Fe^{2+} \rightarrow Fe^0$ reduction was calculated to be 12 kcal/mole. Current-voltage studies were made for zirconium and uranium in LiF–NaF–KF. The zirconium reduction appeared to be reversible. Evidence was also noted for the reaction $U^{4+} \rightarrow U^{5+}$ in this melt. A pyrolytic graphite electrode sheathed in boron nitride was developed for use in

molten-fluoride systems. Anodic-stripping voltammetry was proved to be feasible for determining trace quantities of iron in molten salts. Spectrophotometric studies of various molten-salt systems were continued. Molten alkali-metal–alkali-metal-halide systems and the reactions of active metals, such as uranium, with molten-fluoride salts were followed spectrophotometrically. (auth)

13631 (ORNL-3537(p.30-46)) SPECIAL RESEARCH PROBLEMS. J. C. White and P. F. Thomason (Oak Ridge National Lab., Tenn.).

The applicability of the pyrolytic graphite indicating electrode in various phases of electroanalytical chemistry was investigated. Potentiometry, voltammetry, amperometry, and coulometry were included in this study. A rotating pyrolytic graphite electrode was fabricated for possible use in molten salts. Coulometry of silver and iron was evaluated by use of the pyrolytic graphite electrode and the high-sensitivity coulometric titrator. Polarography with the horizontal-orifice Teflon D.M.E. was continued to obtain fundamental polarographic data. The thallium and lead reduction systems were used as references. Absorption spectrophotometric studies of plutonium in aqueous nitrate systems were subjected to computer resolution to interpret polymer formation as a function of acidity, temperature, and concentration. The radiolysis of chloride solutions was studied to determine the rate of generation of chlorine. Below 1.4M chloride, no chlorine was formed. Radiation and thermal studies were conducted on sodium chloride. (auth)

13632 (ORNL-3537(p.47-57)) REACTOR PROJECTS. J. C. White and A. S. Meyer (Oak Ridge National Lab., Tenn.).

Studies in process gas chromatography were continued for application in the Gas-Cooled Reactor project. A process chromatograph with infrared analyzer was adapted for use in hydrogen autoclave tests to determine methane, nitrogen, carbon monoxide, and carbon dioxide. Another instrument was used to monitor gases (H_2, CO_2, CO, O_2, N_2, CH_4) in a high-temperature steam-graphite loop. Methods development and evaluation were continued for the analysis of the radioactive MSRE fuel. Methods for zirconium, uranium, fluoride, and chromium were completed. The determination of the reducing power due to U^{3+} in the MSRE fuel was studied. Molten $KHSO_4$–H_3BO_3 is used as a flux to dissolve the fluoride salts except for UF_3, which appears to be insoluble in the melt. A facility for analysis of alkali metals was completed. Research and development activities in the analysis of interstitials (oxygen and carbon in particular) in Na, NaK, and K were transferred and implemented in this laboratory. (auth)

13633 (ORNL-3537(p.60-4)) X-RAY AND SPECTROCHEMICAL ANALYSES. (Oak Ridge National Lab., Tenn.).

An x-ray fluorescence procedure was devised for determining Gd_2O_3 in Gd_2O_3–Al_2O_3 ceramics. Procedures were worked out to compensate for neighboring absorption edge effects in x-ray absorption edge analysis. A disposable cell was designed for the x-ray absorption edge analysis of radioactive solutions. In atomic absorption analysis, studies were made of the effects of hollow-cathode current and absorption-tube length on absorbance. Tin was detected by this method at the 0.5-μg/ml level. The ammonium phosphomolybdate adsorption–flame photometry method was adapted for the determination of cesium in sea water. Further studies of volatilization losses during the ashing of tissue confirmed previous results and failed to show evidence of loss of vanadium. Installation of a punched-tape readout on the Quantometer reduced analytical time by one-fifth. (auth)

13634 (ORNL-3537(p.66-7)) INFRARED SPECTROSCOPY. C. A. Horton and Lucy E. Scroggie (Oak Ridge National Lab., Tenn.).

The infrared spectra of radioactive solids were measured by encapsulating the sample in KBr, pressing it at 8 tons for 12 min, and then reencapsulating the pellet with additional KBr. Waxes were identified that resulted from the hydrolysis of uranium carbides. Infrared spectra were obtained of the 4-sec-butyl-2-(α-methylbenzyl)phenol adducts with cesium to determine the polymeric character of the partially hydrogen-bonded hydroxyl group. (auth)

13635 (ORNL-3537(p.68-70)) OPTICAL AND ELECTRON MICROSCOPY. M. T. Kelley, T. E. Willmarth, H. W. Wright, and T. G. Harmon (Oak Ridge National Lab., Tenn.).

Investigation of methods for the study of radioactive materials by electron microscopy and diffraction was continued. An apparatus for the replication of such surfaces was designed. A device for the collection of radioactive particles by electrostatic precipitation was fabricated and put to use. An electron microscope with a resolution of 5 to 10 Å is being installed. Research assistance in electron microscopy and thin film work was given to other divisions. (auth)

13636 (ORNL-3537(p.71-105)) NUCLEAR AND RADIOCHEMICAL ANALYSES. J. C. White and W. S. Lyon (Oak Ridge National Lab., Tenn.).

The decay schemes of Lu^{177m}, Mo^{99}, In^{116}, Cl^{38}, Ba^{131}–Cs^{131}, Te^{129m}, and S^{37} were studied. A 180° Compton-scattered–annihilation gamma sum peak observed in gamma spectrometry was explained. Work was continued on the decay schemes of even isotopes in the osmium region. A gamma spectrometric method for determining Cf^{252} was developed. Work was begun on the determination of fission yields of krypton and xenon nuclides. The half lives of Sn^{127}, Ba^{133}, and Cs^{137} are being remeasured. Solvent-extraction studies included cesium and rubidium with 4-sec-butyl-2-(α-methylbenzyl)phenol, and cesium and tin with 2-thenoyltrifluoroacetone. Solvent-extraction properties of the sulfur analogs of several organophosphorus compounds were investigated. The chemical effects of isomeric transitions resulting in the separation of the isomers of the isotopes Te^{121}, Te^{129}, and Te^{127} were elucidated. Efforts to develop a glass-loaded liquid scintillator were continued; a liquid scintillator for neutron detection and a "balanced quenching" technique for liquid scintillation counting were developed. Improvements and additions to methods and equipment used in low-level analysis for Sr^{90} and other radionuclides were made, optimum methods for low-level counting were outlined, and low-level methods for natural radionuclides were completed. Use of computer techniques increased: equilibrium distribution of metal ion complexes was calculated and plotted, a number of applications were made in nuclear analyses, 16 spectra are in the library for electronic resolution of gamma spectra, a computer program for the calculation of various nuclear parameters was developed, and second-order interference in activation analysis was evaluated by computer techniques. Applications of radioisotopes to analytical chemistry included a method for study of wear rates in automotive engines, a method for determining mercury by isotopic exchange and extraction, and a study of radioisotopes in electroanalysis. The photoneutron method for determining beryllium was evaluated and made available for routine work. A number of applied radiochemical studies were made, most of which involved gamma spectrometry. Decay products from fission-produced krypton and xenon isotopes were collected and

measured, and mixtures of uranium and fission products were measured. The nuclide Sr^{90} was measured in $SrTiO_3$. The radiochemistry of the pressurized-water in-pile loop of the ORR received continuing study. The fast-neutron cross sections for (n,p) reactions on Al^{27} and Ti^{46} were measured. Activation analysis was applied to a number of forensic problems: physical evidence, drugs, heroin, opium, and hair. Allied with these applications were studies in the determination of trace elements in hair, wool, and other biological materials. Work with the 14-Mev neutron generator has continued. Titanium was irradiated, oxygen was determined, and a number of other elements irradiated and studied. Attempts were made to measure and (in one instance) to calculate the neutron spectra from the generator and other neutron sources. A compilation of 14-Mev neutron reactions was prepared; the compilation also includes gamma spectra of the active products. (auth)

13637 (ORNL-3537(p.111-18)) ANALYTICAL DEVELOPMENT. J. C. White and P. F. Thomason (Oak Ridge National Lab., Tenn.).

A polarographic determination of free acid in Tramex process solutions (LiCl matrix) containing aluminum was developed. For a given LiCl concentration, the ratio i_d/C was constant over a hydrogen ion concentration of 1 to 10 mM. Aluminum did not interfere. Lead was determined by atomic absorption spectrometry in prehistoric bones after extracting it with dithizone in hexane from ammoniacal citrate solution. A rapid method for the determination of Hg^{2+} in nitric acid solutions by titration with thiocyanate solution was applied to calciner waste samples; 150 samples were analyzed in six man-days. Conductometric titration was evaluated for the detection of the end point in free-acid titrations of Darex solutions (HNO_3–HCl containing many hydrolyzable ions). The stoichiometry of an erbium manganate sample was established. Efforts to determine the oxidation state of manganese directly were unsuccessful. A polarographic method was used to determine the extent of nitration of 4-sec-butyl-2(α-methylbenzyl)phenol (BAMBP) when contacted with nitric acid. Nonaqueous titrimetry with tetrabutylammonium hydroxide in pyridine was adapted for the determination of phenols in hydrocarbon solutions. Initial studies were made on the potentiometric titration of technetium with chromous sulfate using the pyrolytic graphite electrode. The reduction of Tc^{7+} to Tc^{3+} was found to be a single-step reaction and reproducible to within 1% for 1 to 6 mg of Tc. The high-temperature sealed-tube dissolution technique was found to be useful for organic compounds when quantitative retention for such volatile combustion products as halogens, sulfur, phosphorus, and mercury is desired. Cadmium (0.05 to 0.2%) in HFIR fuel plates (Al, UO_2, B_4C) was determined polarographically, after an ammonium hydroxide precipitation, in 1M NH_4Cl at –0.92 v vs the S.C.E. The molar absorptivities of various lanthanides and actinides complexed with disodium arsenazo III were established. Values in excess of 100,000 were observed for Th, U^{4+}, and Zr. Gas chromatographic analyses were made of Aroclor 1248, a high-boiling organic chloride lubricant, cresols formed by oxidation of gamma-irradiated toluene, and pyrolysis products of biphenyl. (auth)

13638 (ORNL-3558(p.112-16) DEVELOPMENT OF ANALYTICAL METHODS. L. T. Corbin and J. C. White (Oak Ridge National Lab., Tenn.).

A direct, nondestructive method for the determination of Cf^{252} by gamma scintillation counting of the prompt gamma was developed. As little as 10^{-2} nanograms of Cf^{252} can be quantitatively measured. Studies of the applicability of polarography to the measurement of free acid and aluminum in LiCl solutions were undertaken, and the spectrophotometric determination of the rare earths, thorium, and zirconium with Arsenazo III was evaluated. (auth)

13639 (PG-Report-494) ANALYTICAL METHOD FOR THE DETERMINATION OF CARBON IN VANADIUM METAL. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1964. 11p.

Vanadium metal in the form of swarf or powder is ignited at 850°C in an oxygen stream. The carbon dioxide evolved is isolated by means of a cold trap cooled in a liquid oxygen and measured, after expansion at room temperature, as a gas volume. The method is applicable to determination of carbon in vanadium metal in the form of swarf, millings, turnings, or powder. The method is considered to be free from bias. For a single determination on a homogeneous sample the precision is ±30 ppm at the 500 ppm carbon level. The lower limit of detection is 10 ppm carbon. (auth)

13640 (PG-Report-515) ANALYTICAL METHOD FOR THE DETERMINATION OF ZIRCONIUM METAL IN IGNITED URANIUM/ZIRCONIUM RESIDUES. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1964. 11p.

The sample is treated with a solution of bromine in ethyl acetate in which zirconium metal is soluble. After filtration the filtrate is evaporated to dryness and the residue redissolved in acid. Zirconium in separated from uranium by precipitation with mandelic acid, and determined volumetrically in a sulphuric acid solution using standard E.D.T.A. and bismuth solutions. The method is applicable to samples containing 0.1 to 20% w/w zirconium metal in combination with uranium metal or oxides. The determination of zirconium has shown a coefficient of variation of ±0.6% at the 40 mg Zr level. (auth)

13641 (PG-Report-521) ANALYTICAL METHOD FOR THE ABSORPTIOMETRIC DETERMINATION OF BORON IN URANYL NITRATE LIQUOR. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1964. 10p.

After destruction of nitrate with formic acid, boron is separated from uranium by distillation as methyl borate. Any residual nitrate in the evaporated distillate is removed by treatment with aniline sulphate, and boron determined absorptiometrically as rosocyanin. The range of the method is 0.15–1.5 micrograms boron and is applicable to an aliquot of sample containing 3 g uranium. At the 0.4 ppm level (calculated on uranium), the standard deviation is 0.02 ppm. (auth)

13642 (SC-4783(RR)) CHEMICAL AND RADIOCHEMICAL ANALYTICAL PROCEDURES. R. J. Everett, L. W. Brewer, G. W. Edwards, A. J. Jack, T. A. Linn, Jr., and R. O. Mills (Sandia Corp., Albuquerque, N. Mex.). Feb. 1964. Contract AT(29-1)-789. 79p.

Chemical procedures are given for: determination of acid and alkali contaminants in air; determination of benzene, toluene, and other aromatics in air; determination of beryllium; determination of cadmium in air and in urine; determination of chromium in urine; determination of lead in air, swipes, and urine; determination of mercury in urine; determination of composition of organic solvents; determination of thallium in air and in urine; determination of trichloroacetic acid in urine; determination of uranium; and determination of zinc in air. Radiochemical procedures are given for: determination of gross beta activity in soil, urine, vegetation, and water; determination of Cs^{137} in soil, urine, vegetation, and

water; determination of plutonium in urine; determination of Po^{210} in urine; determination of Na^{24} in air, blood, urine, and water; determination of Sr^{90} in soil, vegetation, and water; determination of tritium in urine and in water; and determination of enriched uranium in urine. (M.C.G.)

13643 (SC-DR-250-63) SPECTROCHEMICAL DETERMINATION OF BERYLLIUM IN SWIPE SAMPLES. D. E. Wanner and R. O. Mills (Sandia Corp., Albuquerque, N. Mex.). Jan. 1964. Contract [AT(29-1)-789]. 14p.

An emission spectrochemical procedure is used to analyze swipe samples in which the swipe samples are chemically treated to remove beryllium from the filter paper. The resulting beryllium solutions are analyzed by means of a 1.5-meter photoelectric spectrometer equipped with a rotating disk assembly. The minimum detectable amount of beryllium is 0.05 μg ml. Iron interferes at the lower concentrations of beryllium, but means are described to correct this difficulty. The method is being used for evaluation of efficiency of general beryllium decontamination procedures. (auth)

13644 (UCRL-7616) METHOD AND APPARATUS FOR QUANTITATIVE NEUTRON ACTIVATION ANALYSIS OF LARGE SAMPLES. William H. Hutchin (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 8, 1964. Contract W-7405-eng-48. 56p.

A method and apparatus were devised to irradiate multiple samples of large physical size simultaneously in a nonuniform neutron flux. A capsule containing the samples and flux monitors is rotated about an axis at constant speed with samples fixed in a symmetrical geometry so that each position receives the same integrated neutron flux. (auth)

13645 (AEC-tr-6346) ON THE DISTRIBUTION OF METAL DERIVATIVES OF 8-OXYQUINOLINE BETWEEN WATER AND ORGANIC SOLVENTS. COMMUNICATION NO. 3. PHOTOMETRIC DETERMINATION OF MAGNESIUM AFTER THE EXTRACTION OF ITS OXINATE WITH CHLOROFORM IN THE PRESENCE OF AMINES. Fritz Umland and Werner Hoffmann. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Anal. Chim. Acta, 17: 234-46(1957). 17p.

In the presence of 2% butyl amine magnesium can be extracted quantitatively in the pH range 10.5–13.6 by a 0.1% oxine-chloroform solution (concentration range 0.05–10γ mg/ml), and can be determined photometrically by measurement of the extinction at 380 mμ. This reaction was elaborated to a specific method of determination for small quantities of magnesium in the presence of the most important other elements. Furthermore, determination of magnesium can be combined quite simply with a photometric determination of slight iron content, also as the oxinate. The practical application of the method is demonstrated by determination of magnesium and iron in several calcium minerals, aluminum alloys, and a zinc alloy. (auth)

13646 (AEC-tr-6353) AUTOMATIC MEASUREMENT OF THE PLUGGING TEMPERATURE OF SODIUM AND OF NaK. J. P. Delisle. Translated for Oak Ridge National Lab., Tenn., from paper Presented at "Liquid Metals Colloquium of the European Society of Atomic Energy Aix-en-Provence—Cadarache, Sept. 30–Oct. 1-2, 1963." 19p.

Two processes for the automatic measurement of the plugging temperature were studied and tested: an intermittent and a continuous measurement. The second process, which gave good results, is described in detail. It is still in the course of development. (auth)

13647 (CEA-tr-A-1435) QUELQUES EXEMPLES DE L'UTILISATION DES RADIONUCLIDES EN CHIMIE ANALYTIQUE. (Some Examples of Utilization of Radionuclides in Analytical Chemistry). L. Wodkiewicz. Translated into French from Isotopen Tech., 2: No. 1, 15-16(1962). 9p.

After a brief general discussion of radiochemical methods, the analytical possibilities offered by the use of radioisotopes in the study of analytical procedures and in the determination of trace elements are reviewed. Examples are given. (J.S.R.)

13648 DETERMINATION OF FLUORINE IN ORGANIC COMPOUNDS BY FAST NEUTRON ACTIVATION ANALYSIS. Robert Blackburn (Royal Military Coll. of Science, Shrivenham, Wiltshire, Eng.). Anal. Chem., 36: 669-71(Mar. 1964).

A method was developed for the nondestructive assay of fluorine in organic materials by fast neutron activation. While not as accurate as some chemical methods available, the technique has the advantage of speed and simplicity. Since the accuracy attainable is highly dependent on the counting rate, best results are obtained with large samples. Results with trifluoroacetanilide, p-fluoronitrobenzene, poly(chlorotrifluoroethylene), Teflon, polymeric fluorochlorocarbon greases, and p-fluorotoluene are tabulated. (P.C.H.)

13649 ACTIVATION ANALYSIS. PRINCIPLES AND APPLICATIONS. J. Hoste (Université, Ghent). Assoc. Belge Develop. Pacifique Energie At., Bull. Inform., 8: Nos. 45-46, 54-7(Oct. 1963). (In French)

Activation analysis is of increasing importance as it is simple, very sensitive, specific, and often non-destructive. The principles of this method are reviewed briefly, and its economic aspects are indicated. Some examples of the utilization of this method industrially are given. (J.S.R.)

13650 THE RE-ACTIVATION ANALYSIS OF ALUMINUM—THE ACTIVATION OF ALUMINUM WITH SPECIAL REFERENCE TO YIELD DETERMINATION. Yuichiro Kamemoto and Shigeru Yamagishi (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Japan, 36: 1411-14(Nov. 1963).

An activation analysis method in which the chemical yield is easily corrected by the re-activation of the counted sample is described. The method is designated as re-activation analysis. The re-activation technique consists of several steps: first irradiation of a sample; addition of a carrier; radiochemical separation; counting of the induced activity from the first irradiation; sealing of the counted sample in a polyethylene tube; cooling; a second irradiation; and the counting of the induced activity from the second irradiation. For rapid radiochemical separation, a solvent extraction method was adopted. The method was satisfactorily applied to the determination of aluminum. (P.C.H.)

13651 RAPID ANALYSIS OF STRONTIUM AND RUBIDIUM IN MINERALS. A. A. Mills (Dalhousie Univ., Halifax, N. S.). Can. J. Chem., 42: 73-8(Jan. 1964).

Methods are described for the rapid analysis of strontium and rubidium in micas and alkali feldspars by emission spectrography. The elements are determined in a common matrix, excess barium carbonate acting as buffer and internal standard. The techniques are applicable to the analysis of 5-500 ppm strontium in the minerals, with relative deviations of ±5-8%. Semiquantitative results are obtained for 100-150 ppm rubidium in the same materials. The methods were also successfully applied to the analysis of strontium and rubidium in certain whole rocks. Results obtained with the standard granite G-1 and standard diabase W-1 show satisfactory agreement with the recommended values. (auth)

13652 SUBSTOICHIOMETRIC DETERMINATION OF TRACES OF METALS VIA ACTIVATION ANALYSIS AND

ISOTOPIC DILUTION METHODS. Jaromír Růžička and Jiří Starý (Charles Univ., Prague). Chem. Listy, 57: 1025-47(Oct. 1963). (In Czech)

On activating a trace metal by neutron irradiation, extraction and ion-exchange processes can be used to advantage in separating interfering activities. The efficiency of separation was evaluated for a 99.9% recovery of the product with <0.1% cross-contamination by an interfering impurity. The logarithms of the extraction constant K were tabulated for various cations such as Ag^{+}, Al^{3+}, Am^{3+}, Ba^{2+}, Bk^{3+}, Cd^{2+}, Cf^{3+}, Co^{2+}, Cu^{2+}, Dy^{3+}, Es^{3+}, Fe^{3+}, Fm^{3+}, Gd^{3+}, Hg^{2+}, In^{3+}, Ni^{2+}, Pb^{2+}, Pu^{3+}, Pu^{4+}, PuO^{2+}, and others with the organic complexing agents such as acetylacetone (AA) benzoylacetone (BA), dibenzoylmethane (DBM), 8-hydroxyquinolin (Ox), cupferron (Cup), and dithizone (Dz). Use of the equations is illustrated by the separation of Hg from Cu as the acetylacetonates. Trace amounts of Cu, Zn, and Mo in GeO_2 can be determined by extracting the Cu as the dithizonate at pH = 1, Zn as the dithizonate at pH = 7, and Mo as the 8-hydroxyquinolate at a pH = 1.3. This separation by extraction is simpler than the classical method, which involves the distillation of GeO_2, the electrolysis of Cu, and many other steps. The same type of separation may be carried out on an ion exchanger by proper selection of the complexing agent. The stability constants of a number of metals are tabulated for the oxalate complexes, the tartrate complexes, the cyanide complexes, and complexes with NTA (nitriloacetic acid), EDTA (ethylenediamine tetraacetic acid), and HEDTA (1,2-diaminocyclohexane tetraacetic acid). The selective separation of two metals by ion exchange is discussed. (TTT)

13653 RADIOCHEMICAL ANALYSES USING ADSORPTION PLATES. I. THEORY OF METHOD AND RADIUM DETERMINATION. B. Vlcek (Institut fur Arbeitshygiene und Berufskrankheiten, Prague). Collection Czech. Chem. Commun., 28: 3326-36(Dec. 1963). (In German)

It was established that the ions of some radioactive trace elements can be adsorbed from solutions onto plates that are covered with a gelatine layer with dispersed undissolved salts of a nonactive isotope or an isomorphic element. For radium adsorption, a barium sulfate dispersion, prepared similarly to a photographic emulsion, was used. The advantages of this method were shown. (tr-auth)

13654 REMARKS ON THE TEMPERATURE OF A PARTIALLY IONIZED GAS; APPLICATION TO USES IN SPECTROGRAPHY. Henri Triche and Claude Triche (Nouvelle Faculté des Sciences, Toulouse). Compt. Rend., 258: 512-13(Jan 13, 1964). (In French)

A formula relating the temperature of a source to the intensity of the current in the plasma, the electron concentration, and the initial number of atoms is established. The relation reconciles the difference in temperature of a lithium arc and that of an exploded lithium wire source. It is also shown that the average power radiated per atom is approximately proportional to the absolute temperature. (tr-auth)

13655 CHEMICAL SEPARATION AND SPECTROGRAPHIC DETERMINATION OF TRACE AMOUNTS OF RARE EARTHS IN SAP MATERIAL. PART I. E. Cerrai (Laboratori CISE, Milan), Z. Hainski, G. Rossi, and R. Trucco. Energia Nucl. (Milan), 11: 9-17(Jan. 1964).

A chemical procedure based on reversed phase columnar chromatography and aimed at isolating rare earths from a specimen of solid SAP material is described. The calibration of the spectrographic method is also reported. It has a sensitivity limit of 0.01 μg per each individual rare earth. The chemical procedure was extensively investigated and checked using radioactive tracers. By using a 5-g sample a solution of pure rare earths was obtained in a chloride medium. The sensitivity limit of the spectrographic method is low enough to permit the use of a sample of reduced weight (e.g. 1 g). (auth)

13656 DETERMINATION OF IMPURITIES IN NIOBIUM AND TANTALUM. Ju-chin Yu. Hua Hsueh Tung Pao, No. 1, 27-34(Jan. 1964). (In Chinese)

13657 HIGH FREQUENCY TITRIMETRIC DETERMINATION OF THORIUM AND ZIRCONIUM IONS USING PHOSPHATES AS PRECIPITANTS. A. N. Kumar and R. P. Singh (Univ. of Delhi). Indian J. Chem., 1: 514-16 (Dec. 1963).

A procedure for the estimation of thorium and zirconium in aqueous or ethanol-water media employing a 30 Mc high frequency titrimeter is described. The method involves precipitation of thorium and zirconium by diammonium hydrogen phosphate and potassium dihydrogen phosphate, respectively. Two distinct breaks are observed in the titration curves of zirconium and thorium, showing the formation of two compounds. In the case of thorium the ratio of thorium and phosphate ions in the compound formed at the first break is 1:1. The formation of such a compound of thorium is reported for the first time and was confirmed by analysis, and conductometric and pH titrations. (auth)

13658 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM(VI) WITH ERIOCHROME BLACK-T. L. G. Krishnamoorthy and T. K. S. Murthy (Atomic Energy Establishment, Trombay, India). Indian J. Chem., 2: 51-3 (Feb. 1964).

An accurate and sensitive spectrophotometric method for the determination of U(VI), employing Eriochrome Black-T (EBT), is described. The method involves prior extraction of U(VI) with ethyl acetate using aluminum nitrate as the salting-out reagent, evaporation of ethyl acetate, development of color with EBT and finally measuring the color intensity at 620 mμ and at pH 9. The prior extraction of U(VI) with ethyl acetate eliminates interference due to a number of anions and cations. Practically complete recovery of U(VI) is obtained in a single extraction. The method was successfully applied for U(VI) determination in leach liquors obtained by treating low grade uranium ores with dil. sulphuric acid. The method has a greater sensitivity than many other methods in use. (auth)

13659 AN IMPROVED PHOSPHOR FOR DETERMINING THE SPECIFIC ACTIVITY OF BLOOD GLUCOSE BY LIQUID SCINTILLATION. G. B. Jones and N. F. Henschke (Univ. of Adelaide, South Australia). Intern. J. Appl. Radiation Isotopes, 14: 618-20(Dec. 1963).

An improved phosphor consisting of naphthalene, 2,5-diphenyl oxazole (PPO), p-bis-(2-(5-phenyl oxazolyl))-benzene, and methanol was found to dissolve boric acid quite readily and to have suitable solvent properties for phenyl glucosotriazole. This permits the counting of greater quantities of triazole in smaller volumes of phosphor (5 ml), resulting in improved counting efficiency and lower backgrounds. A liquid scintillation counter fitted with a single photomultiplier tube that functions with a low background count up to room temperature permits the use of the modified phosphor between 0°C and room temperature. The composition of the recommended phosphor is given. (P.C.H.)

13660 RADIOCHEMICAL RECOVERY STUDIES OF A SEPARATION SCHEME FOR 23 ELEMENTS IN BIOLOGICAL MATERIAL. P. O. Wester (Karolinska Institutet,

Stockholm), D. Brune, and K. Samsahl. Intern. J. Appl. Radiation Isotopes, 15: 59-67(Feb. 1964).

An investigation concerning the determination of 23 elements in trace quantities in biological specimens by means of an ion-exchange separation technique combined with γ spectrometry was carried out. Studies were made of reproducibility and of recovery of: Ag, As, Au, Ba, Br, Cd, Ce, Co, Cr, Cs, Fe, Hg, La, Mo, P, Rb, Sb, Sc, Se, Sn, Te, W, and Zn. Known amounts of activities of the elements to be determined were added to biological specimens such as human heart and liver tissue. The organic material was destroyed with sulfuric acid and hydrogen peroxide and the different elements separated by means of a combined distillation and ion-exchange separation technique in groups suitable for γ-spectrometric analysis. Recovery values $\geq$90% were obtained for all elements except Se and Au. A standard error of the mean value $\leq$3% was obtained for all elements. (auth)

13661 PAPER CHROMATOGRAPHY OF I^{131}-LABELED OLEIC ACID AND I^{131}-LABELED TRIOLEIN. L. J. Anghileri (Comision Nacional de Energia Atomica, Buenos Aires). Intern. J. Appl. Radiation Isotopes, 15: 95-6(Feb. 1964).

A paper chromatography method was developed using cupric hydroxide-impregnated paper for the analysis of I^{131}-labeled triolein and I^{131}-labeled oleic acid. A chloroform-benzene (2:1) system satisfactorily resolves the radioiodinated compounds and also detects the presence of free iodide. The paper is prepared by immersion first in 5% cupric sulfate solution, and then, after drying, in a 5% sodium hydroxide solution, followed by washing. (P.C.H.)

13662 SPECTROCHEMICAL DETERMINATION OF INDIUM IN URANIUM–INDIUM ALLOYS. PART I. (0.2–6 WT % OF In). Sima Held and Irena Schoenfeld (Soreq Research Establishment, Nahal Soreq, Israel). Israel J. Chem., 1: 86-90(Oct. 1963). (IA-796)

A method for the determination of indium in uranium-indium alloys in the concentration range 0.2–6 wt % of indium is described. Hydrochloric acid solutions of the sample are excited by the copper spark technique and the intensity ratios of the analytical lines: In I 4101.77A and U II 4090.14A are determined photometrically and related to the concentration of indium. The coefficient of variation of a single determination of indium concentration is about 10% in the concentration range 0.5–6 wt % of indium, and about 17% for lower concentrations. The limit of detection is 0.1 wt % of indium. (auth)

13663 THE DETERMINATION OF MICROGRAM QUANTITIES OF INDIUM IN HIGH PURITY URANIUM. Irena Schoenfeld (Soreq Research Establishment, Nahal Soreq, Israel). Israel J. Chem., 1: 136-41(Dec. 1963). (IA-817)

Microgram quantities of indium were separated from uranium by ion exchange as an anionic complex in hydrochloric acid. The completeness of the separation was established using In^{114} as tracer. Indium in the water eluate was determined spectrographically by d-c-arc excitation. The coefficient of variation for a single determination is about 25%; the absolute limit of detection is 0.01 μg of indium. (auth)

13664 SPECTROCHEMICAL DETERMINATION OF INDIUM IN URANIUM–INDIUM ALLOYS. PART II. (0.02–0.2 WT %). Irena Schoenfeld and Sima Held (Soreq Research Establishment, Nahal Soreq, Israel). Israel J. Chem., 1: 147-9(Dec. 1963).

A method is described for the determination of In in U-In alloys at concentrations below 0.2 wt % In. The d-c arc method was used and KCl was used to enhance the indium analytical line and suppress the uranium ion spectrum. The visually established limit of detection is 0.01 wt % of In. The results were compared with those of other techniques. (P.C.H.)

13665 ISOTOPE-DILUTION ANALYSIS OF AMINO-ACIDS. PART II. THE SENSITIVITY OF THE METHOD. W. R. Waterfield (Radiochemical Centre, Amersham, Bucks, Eng.). J. Chem. Soc.: 541-2(Jan. 1964).

A reverse isotope-dilution technique was used for the optical analysis of radiochemically inactive amino acids through the formation of (α-C^{14})benzyloxycarbonyl derivatives. The method is illustrated by analysis of D-asparagine. (P.C.H.)

13666 RADIOACTIVITY OF A SPUTNIK 4 FRAGMENT. M. W. Rowe, E. C. Anderson, and M. A. Van Dilla (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res., 69: 831-40(Mar. 1, 1964).

A nondestructive γ spectrometry technique was used to assay quantitatively the Mn^{54}, Sc^{46}, and V^{48} concentrations in a 6.35-kg steel fragment of the USSR Sputnik 4 satellite recovered after a cosmic-ray exposure of 843 days. The upper limits for Co^{60} and/or Fe^{59} activities are also presented. The results (119 $\pm$ 8 dpm/kg Mn^{54}, 11 $\pm$ 5 dpm/kg Sc^{46}, 38 $\pm$ 10 dpm/kg V^{48}, and $\leq$9 $\pm$ 5 dpm/kg Fe^{59} and/or Co^{60}, all at time of fall) are compared with the results obtained for the Aroos iron meteorite and the proton (3-Bev) bombardment of iron samples, as well as those obtained by other workers. The value for the Mn^{54} content of Sputnik, though in disagreement with other workers, is just the value expected when comparing with Aroos (and irradiated iron) after correcting for the shielding to which Sputnik was subjected. The Sc^{46} and V^{48} concentrations were in agreement, whereas that of Co^{60} was in gross disagreement with the results of other workers. (auth)

13667 A METHOD OF RADIOCHEMICAL DETERMINATION OF CESIUM-137 IN HUMAN URINE. Masami Izawa, Hiroyuki Tsubota, and Minoru Tano (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiation Res. (Japan), 4: 1-7(Mar. 1963).

Analytical method to determine cesium-137 in human urine was studied. Cesium-137 with cesium-carrier was adsorbed on solid ammonium molybdophosphate in acidified urine. The precipitate was dissolved with alkaline solution, and cesium was separated with a column of phenol-sulfonic acid type cation exchange resin. Cesium was finally precipitated as cesium perchlorate and its β activity was measured with an anticoincidence low-background Geiger-Müller counter. A few $\mu\mu$C of cesium-137 in a sample solution could be determined by the method. The method was used in a routine survey program of cesium-137 contamination of human urine since 1961. This method can also be applied to the determination of cesium-137 in natural waters. (auth)

13668 A COMPARISON OF ANALYTICAL TECHNIQUES USED FOR DETERMINATION OF FALLOUT CESIUM IN SEA WATER FOR OCEANOGRAPHIC PURPOSE. T. R. Folsom (Scripps Inst. of Oceanography, La Jolla, Calif.) and Katsuko Saruhashi. J. Radiation Res. (Japan), 4: 39-53(Mar. 1963).

Replicate samples of sea water were analyzed for cesium-137, both at Meteorological Research Institute and Scripps Institution of Oceanography (SIO) for overall comparison of assay. Also analyses done partly on ship were compared with analyses done entirely in the laboratory. Agreement was good in spite of entirely different

techniques and different primary standards. The independent assays of the two separate laboratories had average difference of only 10%. Replicate of coastal sea water were analyzed for fallout cesium at SIO simultaneously by precipitation with ferrocyanide and also with ammonium molybdophosphate (AMP). Relative yields were determined under conditions close to those used for actual oceanographic purposes. Chemical yield resulting from precipitating known amounts of cesium 134 tag in sea water as nickel ferrocyanide was determined and from this, together with the relative yield data, the recovery effectiveness of analyses using ammonium molybdophosphate precipitation was deduced. Recovery of known amounts of radiocesium from sea water by scavenging with ammonium molybdophosphate gave average yields of 94 ± 3% and indicated that the sorbtive efficiency of AMP in sea water was higher than has been reported. Studies of the fundamental behavior of AMP in sea water were initiated. (auth)

13669 THICK PROBE BETA SELF-ABSORPTION COEFFICIENTS IN 4π COUNTING. K. Faehrmann (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 7: 9-11(Jan. 1964). (In German)

The β self-absorption factors for the detection of P^{32} in sulfur as well as Mg^{27} and Na^{24} in aluminum by counting in 4π geometry are given. The ratios of the correction factors were checked by irradiation of the thick samples in a fission-neutron spectrum. Besides, the factor for sulfur was derived with the help of the angular distribution of the beta intensity of a thick sample and known correction factors for detector geometry with small solid angles. (tr-auth)

13670 HYDROGEN DETERMINATION BY THE NEUTRON METHOD. V. Schuricht (Technische Universität, Dresden). Kernenergie, 7: 42-4(Jan. 1964). (In German)

By experimental investigations it was shown that in the case of hydrogen determination by the neutron method in organic liquids both the carbon content and the oxygen content must be considered. In the neutron moisture measurements on the other hand usually only the hydrogen content plays the decisive role, since additional light nuclei produce only small contributions to the measurement effects, which are masked by other disturbance parameters. (tr-auth)

13671 NEUTRON CHAMBER HUMIDITY MEASUREMENT. V. Schuricht (Technische Universität, Dresden). Kernenergie, 7: 44-5(Jan. 1964). (In German)

By experimental investigation it was shown that neutron ionization chambers at sufficiently large response probabilities against thermal neutrons could be used for moisture measurements and therefore for stationary moisture measurement installations are recommended as neutron detectors. (tr-auth)

13672 DENSITY EFFECT COMPENSATION IN NEUTRON HUMIDITY MEASUREMENT. V. Schuricht (Technische Universität, Dresden). Kernenergie, 7: 45-8(Jan. 1964). (In German)

The influence of the density of the measured material on neutron moisture measurements and the possibility of its consideration are discussed,and two methods for compensation of the density of the measured material are proposed. (tr-auth)

13673 DETERMINING TRACES OF TIN AND IMPURITIES IN ZIRCONIUM AND ITS ALLOYS. Tsugio Takeuchi, Masami Suzuki, and Takumi Nishimura. Kogyo Kagaku Zasshi, 65: 895-8(June 1962). (In Japanese)

Zr and Zr alloys containing Sn are decomposed by acids and the Sn is extracted by means of methyl isobutyl ketone. The quantity of extracted Sn is determined by polarography. The other impurities accompanying the extracted Sn have no influence on the quantitative determination. (Rev. Metal Lit. 21: No. 2, Feb. 1964)

13674 ON THE MEASUREMENT OF TRITIUM IN ROOM AIR. K. H. Waechter. Mitteilungsbl. Strahlungsmessgeraete, No. 6, 11(Oct. 1961). (In German)

The detection probability of tritium using a gas-flow ionization chamber was estimated. An example is discussed. (M.C.G.)

13675 THE QUANTITATIVE ANALYSIS OF DOUBLY LABELED SUBSTANCES WITH THE HELP OF A SINGLE-CHANNEL GAMMA SPECTROMETER, FOR EXAMPLE, URANIUM- AND POTASSIUM-CONTAINING FERTILIZER. K. H. Waechter. Mitteilungsbl. Strahlungsmessgeraete, No. 10, 7-10(Sept. 1963). (In German)

The quantitative determination of two radioisotopes in the same substance with the help of a single-channel gamma spectrometer is discussed. As an example the determination of the K_2O content in fertilizer mixtures by measurements of K^{40} is described. Uranium and its daughter products are sometimes incorporated in the fertilizer in the phosphate part. The 1.4 Mev line of K^{40} must therefore be identified with a gamma spectrometer along with the 0.607 Mev line of Bi^{214}, a decay product of uranium. First, the spectrum of a pure potassium salt was determined. Then the spectrum of a substance known to contain no potassium, in which an equal amount of finely pulverized pitchblende was distributed, was measured. These spectra were compared with the spectra of the fertilizer. (M.C.G.)

13676 EXPERIENCE IN THE FIELD OF ACTIVATION ANALYSIS. H. Schmied and U. Bergamin (Brown Boveri and Co., AG, Baden, Ger.). Neue Tech., 5: 732-44(Dec. 1963). (In German)

In a series of examples it is shown in which fields the method of activation analysis was used. The method was used to determine impurities in materials such as silicon, silicon carbide, molybdenum sulfide, graphite, steel, oil, selenium, and bismuth, and to study physical-chemical processes in which the amounts of materials involved were very small. Determination of an element was made by measuring one of its radioisotopes produced in a reactor. For the identification of the gamma rays a multichannel analyzer was used. In many cases radiochemical separations had to be used. (auth)

13677 DETERMINATION OF SODIUM, ANTIMONY, ARSENIC, AND COPPER IN LEAD METAL BY NEUTRON ACTIVATION ANALYSIS WITH RADIOCHEMICAL SEPARATION. Yuichiro Kamemoto and Shigeru Yamagishi (Japan Atomic Energy Research Inst., Tokyo). Nippon Kagaku Zasshi, 84: 823-6(Oct. 1963). (In Japanese)

A destructive neutron activation method was applied to the determination of small amounts of impurities in lead metal. About 1 g of the sample was irradiated simultaneously with standard either at a neutron flux of about 3×10^{11} n/cm^2/sec for 3 day, or 2 hr, or at a neutron flux of about 10^{12} n/cm^2/sec for 20 min or 32 hr. Antimony, arsenic, and copper in the irradiated lead metal were isolated chemically as antimony trisulfide, arsenic trisulfide, and cuprous thiocyanate in the radiochemically pure state and were determined by the total gamma ray measurements, comparing the activities of Sb^{122}, As^{76}, and Cu^{64} with those of standards. Sodium was determined by the gamma spectrometry, comparing the photo-peak height of Na^{24} with that of standard. All the results were compared with those

of the nondestructive method. Not much difference was observed between the results of the two methods, except in the case of arsenic and copper. The large difference between the analytical results of arsenic and copper in the two methods may be due to the fact that, in the non-destructive method, the analysis of the decay curve of the photopeak at about 0.5 Mev into the decay curves of Cu^{64} (half life: 12.8 hr), As^{76} (half life: 26.8 hr) and Sb^{122} (half life: 2.8 day) was not correct. (auth)

13678 DETERMINATION OF THORIUM WITH TROPOLONE-SULFONIC ACID. Yoshinaga Oka and Misao Umehara (Tohoku Univ., Sendai). Nippon Kagaku Zasshi, 84: 928-32(Nov. 1963). (In Japanese)

Thorium formed a 1:1 chelate with tropolone-5-sulfonic acid in a strong acidic solution and a 1:2 chelate in a solution of pH about 3.0. The stability constants of these chelates were determined spectrophotometrically and found to be 9.0×10^7 and 1.4×10^6, respectively at 25°C and ionic strength of 2.00. For the determination of a small amount of thorium, the 1:2 chelate was used with good results. Beer's law held and the molar extinction coefficient of the 1:2 chelate was 20,000 at 385 mμ. (auth)

13679 A METHOD FOR THE EXPERIMENTAL DETERMINATION OF RADIOISOTOPE CONCENTRATIONS IN HUMAN ORGANS BY EXTERNAL COUNTING TECHNIQUES. G. Fava and G. L. Buraggi (Università, Milan). Nucl. Med., 3: 372-81(1963).

A procedure for measuring organ concentration of radioactivity in subjects who were given a radioactive substance either orally or intravenously is described. The procedure is based on measurements with a properly collimated scintillation counter, a single-channel analyzer and a scaler. Experiments were done using phantoms of different types, simulating some geometrical situations occurring in patients. In vivo controls were performed in some cases at surgical operations. It is believed that the suggested procedure, if carried out properly, can be successfully used in practice and is especially useful when the concentration cannot be determined directly by counting samples drawn from the regions of interest. (auth)

13680 ACTIVATION ANALYSIS OF ANTIMONY BY SUM-COINCIDENCE SPECTROMETRY. Freddy Adams and Julien Hoste (Ghent Universiteit). Nucleonics, 22: No. 3, 55-7(Mar. 1964).

The activation analysis of Sb by sum-coincidence gamma spectrometry is reported with increased sensitivity by a factor of 32. The lead samples contained, in addition to Sb, other impurities, of which Ag was corrected for in the spectrum. (R.E.U.)

13681 NUCLEAR HIGHLIGHTS IN SPECTROMETRY AND ACTIVATION ANALYSIS. Vincent P. Guinn (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucleonics, 22: No. 3, 70; 72; 74-6(Mar. 1964).

The development of neutron activation analysis and the associated use of gamma scintillation spectrometry in various analytic fields are discussed. 25 references. (R.E.U.)

13682 DETERMINATION OF IMPURITIES IN METALLIC BISMUTH BY NEUTRON ACTIVATION. Ludmila Wodkiewicz (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 545-52(1963). (In French)

A method for the determination of some trace impurities in metallic bismuth was developed for Ag, As, Sb, Cu, Fe, Na, and Mn. Application of the multichannel gamma spectrometer gave a rapid and precise analysis. (auth)

13683 RAPID DETERMINATION OF LEAD IN POLYMETALLIC ORE SAMPLES BY ABSORPTION ANALYSIS. Bohdan Dziunikowski. Nukleonika, 8: 553-63(1963). (In Polish)

The absorption method for the rapid determination of lead content in ore samples, with different concentrations of zinc and iron, is described. Theoretical possibilities to avoid the errors due to these elements is presented. An original solution of the problem based on the nomographic method is given. The experimental results and accuracy of the method are discussed. (auth)

13684 APPLICATION OF BACK-SCATTERING OF β-PARTICLES FOR DETERMINATION OF THE HEAVY ELEMENTS IN THE SAMPLES OF VARIABLE MATRIX. Bohdan Dzienikowski and Andrzej Lubecki. Nukleonika, 8: 687-94(1963). (In Polish)

Application of the beta backscattering method for determining the lead content in samples having different chemical composition is described. The original procedure of matrix-effects elimination, as well as experimental results, are presented. (auth)

13685 AN IMPROVED METHOD FOR DETERMINATION OF CESIUM-137 IN RAINWATER. Juliusz Derecki (Center of Radiation Protection and Radiobiology, Warsaw), Jan Geisler, and Zbigniew Jaworowski. Nukleonika, 8: 783-5(1963).

A method is described for the determination of Cs^{137} in rainwater in amounts of approximately 1 pC. The method is based on the ion exchange of Cs^{137} on ammonium molybdophosphate mats. No asbestos is used. The mean recovery of Cs^{137} from water samples was found to be $99.29 \pm 0.32\%$. (P.C.H.)

13686 SEPARATION OF URANIUM FROM INTERFERING ELEMENTS BY ION EXCHANGE RESINS, AND COLORIMETRIC DETERMINATION. Anna Maria Marabini (Centro di Studi per la Preparazione dei Minerali, Rome). Ric. Sci., Rend., Sez. A (2), 3: 919-38(Nov. 1963). (In Italian)

A rapid method was applied to determine uranium in pitchblende and autunite minerals. The sample was decomposed by $H_2SO_4 - MnO_2$, uranium was separated from interfering elements by adsorbing it on an ion exchange resin (Amberlite IRA-400, 30 to 40 mesh, and Dowex 1-X, 20 to 50 mesh), and finally uranium was colorimetrically estimated in an alkaline peroxide solution. Details of procedure are discussed, and experimental data in support of the principal steps of the procedure are given. Accuracy and reproducibility were investigated on a wide range of concentrations. (auth)

13687 ION EXCHANGE METHODS FOR MEASUREMENT OF THE BETA ACTIVITY OF WATER AND FOR STRONTIUM-90 DETERMINATION IN WATER AND ASHES. A. Hinzpeter. Schriftenreihe Bundesmin. Wiss. Forsch., Strahlenschutz (Munich), No. 23, 1-50(1963). (In German)

The method developed for determination of total beta activity of water and the Sr^{90} activity of water and ashes is a pure ion exchange method without chemical intermediate processes for routine operation. It proceeds in two stages: total adsorption of the radionuclides on ion exchangers (total beta activity + Sr^{90} determination) or selective adsorption (only Sr^{90} determination) and selective elution of Y^{90} for measurement of Sr^{90} activity. The cation exchanger and its selective properties, the practice of exchanger adsorption, and Y^{90} determination are described. (M.C.G.)

13688 DETECTION AND QUANTITATION OF FALLOUT PARTICLES IN A HUMAN LUNG. Audrey V. Wegst, Charles A. Pelletier, and G. Hoyt Whipple (Univ. of Michigan, Ann Arbor). Science, 143: 957-9(Feb. 28, 1964).

Portions of an adult human lung were studied by autoradiography in order to detect the presence of fallout particles. The radioactivity in the remainder of the tissue was determined with a gamma spectrometer. Four particles were found and their activities were determined. From the measurement for total-fission-product activity in the lung tissue it was calculated that there were approximately 264 particles in the right lung at the time of death. (auth)

13689 DIFFUSE REFLECTANCE SPECTRA OF TEN RARE EARTHS. Lois B. Jassie (Bell Telephone Labs., Inc., Murray Hill, N. J.). Spectrochim. Acta, 20: 169-77 (Feb. 1964).

The diffuse reflectance spectra of certain trivalent rare earth chlorides and tungstates are reported. The spectra were obtained in the 375–1200 mμ wavelength region for powdered materials approximately 2-13 μ in diameter. The correlation of the spectra with reported absorption data indicates the feasibility of using this technique for the qualitative identification of Pr, Nd, Sm, Eu, Tb, Er, Ho, Dy, Tm, and Yb. (auth)

13690 APPLICATION OF THE ANALYTICAL METHOD OF REFLECTION OF β RADIATION IN Pb–Cu, Pb–Sn, Zn–Cd, AND Pb–PbO SYSTEMS. Raluca Ripan, Gheorghe Marcu, and Gheorghe Murgu. Studia Univ. Babes-Bolyai, Ser. Chem., No. 1, 53-9(1962). (In Rumanian)

Analyses of binary Pb–Cu, Pb–Sn, Zn–Cd, and Pb–PbO indicated a direct proportion between the reflected β intensity and the content of heavy metal. Such an analysis may be carried out within a few minutes with an error of less than 1%; for Pb–PbO, the error is 1 to 2%. (tr-auth)

13691 SPECTROSCOPIC DETERMINATION OF THE ISOTOPIC COMPOSITION OF NITROGEN. G. S. Lazeeva, A. A. Petrov, and V. V. Fedorov. Vestn. Lenningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 56-61(1963). (In Russian)

A photoelectric method was developed for the purpose of determining nitrogen isotopic composition. The analysis is carried out by the band heads of N_2 molecule with positive and negative isotopic shift. The dependence of the results upon the experimental conditions was explained as due to the change of rotational temperature and the way of accounting for this effect was proposed. (auth)

13692 ISOTOPIC SPECTRAL ANALYSIS OF BORON. A. G. Zhiglinskii and A. S. Kochemirovskii. Vestn. Lenningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 62-8 (1963). (In Russian)

Some methods of determination of boron isotopic composition by the atomic spectrum (the analytic line BII λ = 3451 Å) and by the molecular spectrum BO (band 1–0 of β-system, λ = 2255 Å) were suggested. The photographic method of registration was used, and the analysis was performed by means of graduated diagrams. The relative error in the determination of the isotope, which is present in a minor quantity, is about 2–5% in the atomic spectrum analysis and 2–3% in the molecular spectrum analysis. (auth)

13693 AMPEROMETRIC DETERMINATION OF THORIUM BY MEANS OF THORON. I. A. Tserkovnitskaya and Ju-chiu Yeh. Vestn. Lenningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 135-6(1963). (In Russian)

The method for determination of thorium content in monazite by thoron titration was suggested. (auth)

13694 PHOTOMETRIC DETERMINATION OF NIOBIUM IN ORES USING ACID CHROME VIOLET K. R. S. Tramm and K. S. Pevzner (State Research and Design Inst. of Rare Earth Industry, USSR). Zavodsk. Lab., 30: 20-2(1964). (In Russian)

A description is given of a photometric determination of Nb in ores using Acid Chrome Violet K with a sensitivity to 2 μg Nb in 10 ml of solution in the presence of other elements. The root mean square error is 6% with a content of 0.1 to 0.2% Nb_2O_5 and 3% with 0.3 to 0.5% Nb_2O_5 in ores. (tr-auth)

13695 USE OF N-BENZOYLPHENYLHYDROXYLAMINE FOR AMPEROMETRIC TITRATION OF TITANIUM, ZIRCONIUM, GALLIUM AND SCANDIUM. Z. A. Gallai, I. P. Alimarin, and N. M. Sheina (Moscow State Univ.). Zh. Analit. Khim., 18: 1442-6(Dec. 1963). (In Russian)

A method was developed for the amperometric titration of Ti and Zr with an N-benzoylphenylhydroxylamine solution in the presence of Ni, Mn, Co, Al, Cr, and Fe, and for Ga in the presence of Al, Mn, Zn, Pb, In, and Fe. A method was also developed for the determination of Sc by back titration of the excess of N-benzoylphenylhydroxylamine with $KMnO_4$, $ZnSO_4$, and $CuSO_4$ solutions. (auth)

13696 USE OF CINNAMIC ACID IN ANALYTICAL CHEMISTRY. 4. DETERMINATION OF BERYLLIUM AND ITS SEPARATION FROM MANGANESE, NICKEL, COBALT AND ZINC. E. A. Ostroumov and I. I. Volkov (Inst. of Oceanology, Moscow). Zh. Analit. Khim., 18: 1452-6(Dec. 1963). (In Russian)

A new method has been developed for the gravimetric determination of beryllium by its precipitation with ammonium cinnamate from a weakly acid solution on heating. Beryllium is separated quantitatively as a crystal precipitate of the basic salt of the invariable composition $C_6H_5 \cdot CH:CH \cdot COO \cdot Be \cdot OH$. The precipitate is sucked off on a sintered glass crucible, washed, dried at 110°C, and weighed. The conversion factor to BeO is 0.1445. The above compound can be ignited to BeO and weighed. The precipitation of beryllium as a basic cinnamate permits its separation from manganese, nickel, cobalt, and zinc. (auth)

13697 PHOTOMETRIC DETERMINATION OF THE TOTAL RARE EARTHS IN NATURAL MATERIALS. E. V. Furtova, G. F. Sadova, F. V. Zaikovskii, and V. N. Ivanova. Zh. Analit. Khim., 18: 1464-7(Dec. 1963). (In Russian)

Conditions were found for the determination of rare earths with arsenazo I in the presence of less or equal amounts of thorium using lactic acid as a masking agent. A study was made of the iodate method for separating thorium from rare earths from a tartaric-nitric acid medium in the presence of hydrogen peroxide and mercuric nitrate as a coprecipitator. A photometric method is suggested for the determination of 0.02–3% of rare earths in ores containing thorium, titanium, and zirconium. (auth)

13698 EXTRACTION-FLUORIMETRIC DETERMINATION OF EUROPIUM AND TERBIUM. L. I. Kononenko, R. S. Lauer, and N. S. Poluektov (Inst. of General and Inorganic Chemistry, Odessa). Zh. Analit. Khim., 18: 1468-74(Dec. 1963). (In Russian)

Conditions were found for the extraction-fluorimetric determination of europium and terbium in the total rare earth oxides. Determination is carried out in benzene solutions of diphenanthrolinetrisalicylate complexes of the elements. Europium is determined by a fluorescent band with the fluorescence maximum at 612 mμ, terbium by the maximum at 543 mμ. Spectra are recorded on a

spectrograph with a photoelectric device, a mercury lamp is used as an ultraviolet radiation source. The determination is carried out by the method of additions. The sensitivity of the method is 0.1–0.2% of Eu and Tb in the total rare earth oxides. (auth)

13699 USE OF A KINETIC METHOD WITH AMPEROMETRIC RECORDING FOR THE DETERMINATION OF MOLYBDENUM AND TUNGSTEN IN CADMIUM SULFIDE AND LITHIUM FLUORIDE MONOCRYSTALS. A. M. Bulgakova and N. P. Zalubovskaya (All-Union Scientific-Research Inst. of Monocrystals, Scintillating Materials and Highly Pure Chemical Substances, Khar'kov). Zh. Analit. Khim., 18: 1475-8(Dec. 1963). (In Russian)

Methods were developed for the determination of down to 5×10^{-6}% of molybdenum and tungsten in cadmium sulfide monocrystals and down to 2×10^{-4}% of molybdenum in lithium fluoride monocrystals. The rate of the iodide ion oxidation with hydrogen peroxide in an acid medium is recorded amperometrically. (auth)

13700 ANALYTICAL APPLICATIONS OF BISAZO DERIVATIVES OF CHROMOTROPIC ACID. S. B. Savvin and Yu. M. Dedkov (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Analit. Khim., 19: 21-7(1964). (In Russian)

Reactions of bisazo-derivatives of chromotropic acid with a number of elements were studied. It was established that the selectivity of the reagents, as well as contrast of the reactions and stability of complexes formed, to a large degree are determined by the nature of the acid radical, which is in an ortho-position to the azogroup, and by the nature of derivatives, which are in meta-positions to the azogroup. The most interesting reactions give the reagents containing the following functional-analytical groupings: o-arsono-o'-hydroxyazogroup (Th, U, TR, Pa, Zr), o-sulfo-o'-hydroxyazogroup (Ba, Sr, Me(I)), o,o'-dihydroxyazogroup (Nb, Zr, Sc, Te), o-phosphono-o'-hydroxyazogroup (U, Sc). Arsenazo III (reagent No. 4) is recommended for the determination of Th, U, Zr, TR, and a number of other elements, and other reagents are recommended for Ba, Sr, Nb, Zr, and Hf. The reagents of this class are highly sensitive and their reaction products are contrasting; it is possible to work in acid media, and they are highly selective when elements forming polynuclear cations are determined. (auth)

13701 DETERMINATION OF SODIUM, POTASSIUM AND CALCIUM IN URANIUM AND ITS COMPOUNDS BY A FLAME PHOTOMETRIC METHOD. G. I. Zhuravlev and I. A. Gavrilova. Zh. Analit. Khim., 19: 54-8(1964). (In Russian)

A study was made of the effect of uranium on sodium, potassium, and calcium radiation as well as the effect of aluminum and vanadium on calcium radiation in an acetylene-air flame. A method is described for the determination of sodium, potassium, and calcium in uranium and its compounds by flame photometry without separation of uranium beforehand. (auth)

13702 QUANTITATIVE DETERMINATION OF SCANDIUM AFTER ITS SEPARATION AS IODIDE COMPLEX WITH DIANTIPYRILMETHANE. V. P. Zhivopistsev and I. S. Kalmykova (Perm State Univ., USSR). Zh. Analit. Khim., 19: 69-72(1964). (In Russian)

A method for scandium determination based on the extraction of its iodide complex with diantipyrilmethane into chloroform followed by the complexonometric determination of the element separated was developed. The method permits the determination of scandium in materials containing lanthanum and all the other rare earths, yttrium, aluminum, chromium, nickel, cobalt, beryllium, magnesium, manganese, and small amounts of titanium, calcium, barium, strontium, iron and alkali metals. On slight modification the method can be used for scandium determination in the presence of zirconium and hafnium. (auth)

13703 SPECTROPHOTOMETRIC STUDY OF SCANDIUM COMPOUND WITH XYLENOL ORANGE. O. V. Konkova (Moscow Univ.). Zh. Analit. Khim., 19: 73-8 (1964). (In Russian)

The interaction of scandium with xylenol orange was studied. It was established that scandium reacts with xylenol orange in the ratio of 1:1. The molar extinction coefficient is 29410, and the pK of the complex unstability is 5.95. (auth)

13704 DETERMINATION OF SAMARIUM OF DIFFERENT VALENCY STATES IN FLUORITE. V. G. Silnichenko and F. I. Dmitrieva (Inst. of Crystallography, Moscow). Zh. Analit. Khim., 19: 84-6(1964). (In Russian)

A titrimetric method is suggested for determining Sm^{2+} in fluorite. Gravimetric, titrimetric, and photometric methods for the determination of $Sm^{2} + Sm^{3+}$ in fluorite were developed in detail. (auth)

13705 PHOTOMETRIC DETERMINATION OF THORIUM IN NATURAL MATERIALS BY MEANS OF ARSENAZO III. E. V. Furtova, G. F. Sadova, V. N. Ivanova, and F. V. Zaikovskii. Zh. Analit. Khim., 19: 94-6(1964). (In Russian)

Conditions are specified for thorium determination in the presence of rare earths and zirconium by means of arsenazo III, and a photometric method is suggested for the determination of 0.0002–0.5% of Th in complex natural materials. Iodate separation from a tartaric-nitric acid medium in the presence of hydrogen peroxide was used for thorium separation from the accompanying elements (Zr, Ca, and rare earths). (auth)

13706 DETECTION OF MOLYBDENUM AS PYROCATECHOL–PYRIDINE COMPLEX. A. I. Busev and G. P. Rudzit (Moscow State Univ.). Zh. Analit. Khim., 19: 102-4(1964). (In Russian)

A molybdenum-pyrocatechol complex compound interacts with pyridine under certain conditions forming a triple pyrocatechol–pyridine–molybdenum complex, which can be extracted with chloroform or methylene chloride. The optimum pH value of the aqueous phase is 4.5. The reaction was used for the development of a selective method for molybdenum detection. (auth)

13707 SEPARATION OF PROTACTINIUM FROM OTHER ELEMENTS BY EXTRACTION WITH N-BENZOYLPHENYLHYDROXYLAMINE. B. F. Myasoedov, E. S. Palshin, and P. N. Palei (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Analit. Khim., 19: 105-11(1964). (In Russian)

A study was made of protactinium extraction by means of N-benzoylphenylhydroxylamine (BPHA) with benzene and other solvents from sulfuric and hydrochloric acid solutions. It was established that on extraction from 7 N H_2SO_4 up to 15 mg/ml of Al^{3+}, Fe^{3+}, Bi^{3+}, Mn^{2+}, Cr^{3+}, Ni^{2+}, Sn^{2+}, Sn(IV), Ti^{3+}, La^{3+}, Ce(IV), Th(IV), and U(IV) do not effect the percent extraction of protactinium with a 0.1 M solution of BPHA in benzene. It was found that protactinium can be separated from iron, niobium, rare earths, thorium, and uranium. A method was developed for separating Pa^{233} from thorium irradiated by neutrons by extraction from 7 N H_2SO_4 with a 0.1 M solution of BPHA in benzene. A color reaction of protactinium with BPHA is described. (auth)

13708 CHEMICO-SPECTROGRAPHIC METHOD FOR THE DETERMINATION OF IMPURITIES IN VANADIUM.

V. N. Muzgin, V. L. Zolotavin, and F. F. Gavrilov (Ural Polytechnical Inst., Sverdlovsk, USSR). Zh. Analit. Khim., 19: 111-16(1964). (In Russian)

A chemico-spectrographic method for the analysis of highly pure vanadium was developed including concentration of impurities by distillation of the base as VCl_4 and $VOCl_3$. The method permits the determination of 19 elements (Be, Mg, Ca, Ba, B, Al, Si, Zr, Cr, Mn, Fe, Co, Cu, Ag, Hg, Tl, Pb, Th, and Cd) with a sensitivity of 10^{-4}–10^{-6}%. (auth)

13709 THE ANALYTICAL CHEMISTRY OF THORIUM. D. I. Ryabchikov and E. K. Gol'braikh. Translation of Analiticheskaya Khimiya Toriya by R. Belcher and L. Gordon. International Series of Monographs on Analytical Chemistry. A. Pergamon Press Book. New York, The Macmillan Company, 1963. 328p. $14.00.

Chemical and physico-chemical methods of determining thorium in natural and industrial materials and methods for determining impurities in the metal are described. The physico-chemical properties of thorium are discussed. More than 2000 references are cited. (R.E.U.)

13710 PEIRSON AND SUM-COINCIDENCE SPECTROMETRY APPLIED TO ACTIVATION ANALYSIS. F. Adams, D. De Soete and J. Hoste (Ghent Universiteit). 17p. (CONF-313-7)

From 2nd National Meeting of the Society for Applied Spectroscopy, San Diego, Calif., Oct. 1963.

A method is described for obtaining gamma spectra with net photopeaks. Using this technique, the signal of a large plastic detector is subtracted from a NaI(Tl) detector and the detectors are positioned at a 90° angle to reduce backscatter by a factor of three. The method was applied to the nondestructive determination of Co in Ni in the concentration range 1 to 5×10^{-5}%. The net photopeaks of Co^{60} were measured versus the net photopeaks of Co^{58}. Reproducibility varies between 4 and 12%, depending on the Co concentration. Sum coincidence offers another possibility to obtain net photospectra. This technique can be applied to gamma emitters that give rise to a cascade or to annihilation radiation. The technique was applied to the nondestructive analysis of Sb in high purity lead by using the 0.603–1.69-Mev cascade of Sb^{124}. The advantages of this method are noted. (P.C.H.)

13711 COMPUTER ANALYSIS OF COMPLEX GAMMA-RAY SPECTRA. A. K. Perkons, R. L. Hummel, and R. E. Jervis (Univ. of Toronto). 16p. (CONF-313-9)

From 2nd National Meeting of the Society for Applied Spectroscopy, San Diego, Calif., Oct. 1963.

In forensic investigations using neutron activation analysis and gamma-ray spectrometry, the main problem is the resolution of the complex gamma spectra. A digital computer program was developed for resolving the spectra into their individual components. The program and its application to the activation analysis of hair are described. (D.L.C.)

13712 RADIOASSAY OF THIN-LAYER CHROMATOGRAMS. Fred Snyder (Oak Ridge Inst. of Nuclear Studies, Tenn.). 7p. (CONF-390-2)

From 8th Symposium on Advances in Tracer Methodology, Chicago, Nov. 1963.

A scintillation solvent system that deactivates silica, thereby preventing adsorption of many polar compounds, is described. The scintillation solution of choice for counting C^{14} (62% efficiency) and tritium (12% efficiency) from silica scrapings has been dioxane (1.5 l), naphthalene (150 g), H_2O (0.3 l), PPO (7 g), and POPOP (0.3 g), and sometimes containing Cab-O-Sil (4%). The H_2O serves to deactivate the silica, since adsorption of radioactivity on silica particles in more nonpolar solvent systems can result in self-absorption losses (≈10% for C^{14} and 25% for H^3) with 10 to 25-μ silica particles. The silica, iodine, dichlorofluorescein, and rhodamine-6G have no quenching properties in this system, whereas elemental carbon (H_2SO charring) causes severe quenching. Recovery of the radioactivity from the plate based on a direct pipetting into a vial serves as an internal check on the total system used in the analysis. The high resolution (1 mm) zonal scans of thin-layer plates reveal that caution must be applied when interpreting radioactivity data from thin-layer plates in which larger areas have been assayed. The 1-mm scans have shown as many as 3 peaks in an area as small as 2 cm wide. ARGs also show overlapping areas of radioactivity, but the resolution obtained is not so clearly delineated as in our scans. External scanning equipment does not resolve the components in an area of this size. The special scraper described for carrying out the rapid quantitative removal of adsorbent into scintillation vials is extremely useful in accomplishing high resolution radioassays of TLC separations made with low-activity biological samples. In order to expand the utility of this procedure, the complete automation of the device is under construction. (auth)

13713 NUCLEAR DETERMINATION OF NITROGEN CONTENT. Jay Tittman, William B. Nelligan, Stephen Antkiw, and Frank F. Johnson (to Schlumberger Well Surveying Corp.). U. S. Patent 3,124,679. Mar. 10, 1964. Filed Dec. 4, 1958.

A neutron-irradiation gamma detection system is described for quantitative determination of nitrogen content in a sample. (R.E.U.)

Inorganic and Physical Chemistry

13714 (AD-415804) A STUDY OF MOLECULAR STRUCTURE BY PULSED NEUTRON TECHNIQUES (thesis). Michael Paul Charles (North Carolina State Coll., Raleigh). 1963. 41p.

Measurements of the thermal neutron diffusion constant (Dc) and the diffusion cooling coefficient of eleven hydrogenous materials and liquid ammonia were made using the 1 Mev Van de Graaff accelerator at North Carolina State College. These values were compared with theoretical values from transport theory and consideration of the molecule as two different models. The atoms were treated, mathematically, in the molecule as being both bound and free, thereby developing two separate equations relating the average cosine of the scattering angle (Ma) for hydrogen, with temperature. Results were good where the differences for Dc between experimental and theoretical values were 3.13% for the bound-atom model, and 5.92% for the free-atom model. Definite correlation between changes in molecular structure and Dc was predicted theoretically with only nominal success experimentally. Separate equations relating Ma and temperature were also developed for water and oxygen. (auth)

13715 (AFOSR-TN-59-1183) A STUDY OF THE GALLIC ACID COMPLEXES OF NIOBIUM, TANTALUM, TITANIUM, AND IRON. E. L. Grove, Lodric Maddox, and W. S. Jeffery (Alabama. Univ., Tuscaloosa). July 26, 1960. Contract AF18(600)-1567. 11p. (AD-415896)

The use of gallic acid in a spectrophotometric procedure

for tantalum, niobium, and other metals was investigated. The optical properties of Nb, Ta, and several other metal chelates were explored. (auth)

13716 (ANL-6769(p.21-9)) DIFFUSION AND ABSORPTION OF GASES IN PLASTIC-WALLED IONIZATION CHAMBERS. J. H. Marshall, R. J. Lari, and Jacob Kastner (Argonne National Lab., Ill.).

In the design of stable, tissue-equivalent ionization chambers, important factors are the solubility and permeability of the wall materials to the contained gases. Diffusion measurements for N_2, O_2, He, CO_2, CH_4, C_2H_6, C_2H_4, and Ne were carried out on thin discs of a variety of tissue-simulating plastics. The data were used for the determination of the equilibrium times and pressure changes to be expected for typical large, thick-walled, ion chambers. (auth)

13717 (CONF-415-2) PROPERTIES OF ORGANIC–WATER MIXTURES. I. ACTIVITY COEFFICIENTS OF NaCl, KCl, AND $Ba(NO_3)_2$ IN SATURATED WATER MIXTURES OF GLYCOL, GLYCEROL, AND THEIR ACETATES. MODEL SOLUTIONS FOR HYPERFILTRATION MEMBRANES. Kurt A. Kraus, Richard J. Raridon, and Willis H. Baldwin (Oak Ridge National Lab., Tenn.). [1962]. Contract W-7405-eng-26. 24p.

From American Chemical Society 15th Annual Southeastern Regional Meeting, Charlotte, N. C., Nov. 1963.

The solubility of NaCl in mixtures of water with ethylene glycol and its mono- and diacetates and glycerol and its mono-, di-, and triacetates was determined at 25°C by packed column techniques. The solubilities of KCl and $Ba(NO_3)_2$ were determined for water mixtures of glycol, glycerol, and the corresponding fully acetylated compounds. Miscibility limits were established in the presence and absence of salts. From the solubility data, activity coefficients, $\gamma_{s(0)}$, of the salts were computed using the same reference states as for aqueous solutions and expressing concentrations in moles/kg water. While the values of $\gamma_{s(0)}$ in the glycol and glycerol water mixtures were usually less than for the two-component aqueous solutions they increased with fraction of hydroxyl groups acetylated and were more than 1000 times larger for the fully acetylated compounds at low water content. Some of the implications of these results on hyperfiltration with membranes are discussed. (auth)

13718 (HW-SA-2880) CONVERSION OF PLUTONIUM NITRATE TO PLUTONIUM TETRAFLUORIDE VIA THE CONTINUOUS OXALATE–FLUORIDE METHOD. H. W. Crocker and H. H. Hopkins, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 25, 1963. Contract AT(45-1)-1350. 20p.

A description is given of the process and equipment for the continuous conversion of plutonium nitrate to tetrafluoride powder for reduction to Pu metal. The conversion involves oxalate precipitation, filtration, calcination, and hydrofluorination. Typical results are described; the product is a free-flowing PuF_4 with a high degree of separation from impurities. (D.L.C.)

13719 (IS-667) ELECTROCHEMICAL PROCESSES IN FUSED SALTS. Lowell Alvin King and F. R. Duke (Ames Lab., Ames, Iowa). July 1963. Contract W-7405-eng-82. 100p.

The practicability of direct current specific conductivity determinations of fused salt systems is demonstrated. Simple conductivity cell design and electrical circuits minimized many of the problems associated with alternating current techniques. Experimentally determined cell constants were very nearly those calculable from cell geometry. The direct current conductivities of $LiNO_3$, $NaNO_3$, KNO_3, and their binary mixtures were determined. Agreement with published alternating current values, where available, was excellent. A carbon dioxide formation cell is described. The cell consisted of a reversible platinum, oxygen cathode, a graphite, carbon dioxide anode, and an oxyanionic electrolyte of fused Na_2WO_4–WO_3 mixtures. Cell voltages were about 20% below theoretical values. It is postulated that the low results arose from reduction or dissociation of the melt, or from slow attainment of gas equilibria at the graphite electrode. Anodic and cathodic overpotentials at each electrode were studied. The platinum electrode exhibited concentration polarization. The graphite electrode probably also exhibited concentration polarization. In all cases of electrode polarization studied, the number of electrons transferred in the rate-determining process was one. (auth)

13720 (IS-727) FORMATION CONSTANTS OF SOME RARE-EARTH COMPLEXES. William Ray Stagg and Jack E. Powell (Ames Lab., Ames, Iowa). Aug. 1963. Contract W-7405-eng-82. 93p.

The stepwise formation constants for complexes between the trivalent metals lanthanum, yttrium, and all of the rare earths, except promethium, and the ligands isobutyrate (IBU), α-hydroxyisobutyrate (AHIB) and α,β,β′-trihydroxyisobutyrate (THIB) were measured at 25°C and an ionic strength of 0.5M ($NaClO_4$). For lanthanum and the first half of the rare-earth series, the magnitude of the formation constants increased in the order IBU, AHIB, THIB. For the remainder of the series and yttrium, the magnitude increased in the order IBU, THIB, AHIB. It was postulated that the inversion of the AHIB and THIB stabilities with increasing atomic number was brought about by a change in the number of coordination sites of the metal which could be occupied by the THIB ligand. The IBU and THIB complex formation constants both exhibit a sinusoidal behavior when plotted as a function of atomic number. Such a plot for the AHIB complexes increases more or less uniformly. Because of this, it was concluded that the AHIB would be the superior ligand to use as an eluant for ion-exchange chromatographic separation of rare-earth mixtures. (auth)

13721 (IS-741) PREPARATION AND REACTIONS OF SOME LOWER TUNGSTEN HALIDES AND HALIDE COMPLEXES. Theodore Martin Brown and Robert McCarley (Ames Lab., Ames, Iowa). Nov. 1963. Contract W-7405-eng-82. 117p.

A method for the preparation of the tungsten(IV) halides, WCl_4 and WBr_4, by aluminum reduction of WCl_6 and WBr_6, respectively, was developed. The reactions are carried out in sealed, evacuated tubes under a controlled temperature gradient and afford virtually quantitative yields of the crystalline tetrahalides, which are deposited from the vapor phase. The halides, WCl_4 and WBr_4, are isomorphous solids of orthorhombic structure and lattice constants a = 8.07, b = 8.89, c = 6.85 Å and a = 8.49, b = 9.29, c = 7.25 Å, respectively; both solids are diamagnetic over the range –196 to 25°C. The preparation of the first simple trihalide, WBr_3, is given. This is accomplished by reacting WBr_2 with liquid bromine. The material is thermally unstable, decomposing at temperatures greater than 80°C. The trihalide appears to be more closely related in structure and properties to the dibromide, rather than the higher tungsten bromides. A convenient synthesis of WCl_2 and WBr_2 in high purity results from the disproportionation of WCl_4 and WBr_4, respectively, at 450° to 500°C. With WCl_4 and WBr_4 readily available from the aluminum re-

duction the preparation of the tungsten dihalides can be completed in a few hours. As with the tetrahalides of niobium and tantalum, tetrahalodi(pyridine)tungsten(IV) complexes result from the reactions of the pure tetrahalides with pyridine. These compounds are also prepared from the reduction of WCl_6 and WBr_5 with pyridine. X-ray-diffraction data indicates that the structure of these solid addition compounds is complex. It does appear, however, that they are isomorphous with each other and with the pyridine addition compounds of niobium and tantalum. The tungsten(IV) halides were found to be good coordinating agents. In addition to forming a stable complex with pyridine, WCl_4 gives stable complexes with 2,2'-bipyridine, 4-picoline, and 4-ethylpyridine. Studies to help elucidate the structure of the pyridine adducts were carried out with the aid of conductance, spectral, and magnetic susceptibility measurements. The complexes are paramagnetic having moments much lower than the spin-only value for two electrons. Solution studies of these complexes in pyridine by conductance and absorption spectra techniques indicated the existence of two species, probably the cis or trans isomer along with the ion, $(W(C_5H_5N)_3Cl_3)^+$, in solution. The spectra of these solutions show intense bands in the visible region which have been attributed to charge transfer transitions. (auth)

13722 (IS-770) OSMOTIC AND ACTIVITY COEFFICIENTS OF SOME AQUEOUS RARE-EARTH CHLORIDE SOLUTIONS AT 25°C. Harry Homer Petheram and F. H. Spedding (Ames Lab., Ames, Iowa). May 1963. Contract W-7405-eng-82. 74p.

The least square equations obtained for the osmotic coefficient as a function of molality for erbium and yttrium chloride solutions resulted in a mean deviation of 0.0019 and 0.0024 in the osmotic coefficient, respectively, for the two solutions. These deviations at a median osmotic coefficient are 0.08% for erbium chloride and 0.10% for yttrium chloride. Of course, the percent error in the osmotic coefficient is larger for the most dilute solutions and lower for the saturated solutions. The corresponding error in the activity coefficient was determined to be about 0.0010 in the $\log \gamma_{\pm}$, while the activity coefficients were in error by 0.008 for $\gamma_{\pm} = 0.3261$ in the dilute solution range or by 0.020 for $\gamma_{\pm} = 9.760$ in the most concentrated solutions of erbium chloride. All deviations in the activity coefficient gave an almost uniform mean deviation of 0.23%. These deviations in the activity coefficient correspond with those expected from the experimental procedure of this type of research. The errors concurred are: the error in analysis of each solution was of the order of 0.05% for molalities greater than one and from 0.10 to 0.15% for molalities less than one; and the reliability of the reference osmotic coefficient data is about 0.0010 in the osmotic coefficient. Since the molalities of two solutions must be known for the calculation of the rare-earth osmotic coefficient, a mean deviation of 0.0020 in its osmotic coefficient determined in this research is within the experimental precision of the isopiestic method. The osmotic and activity coefficients determined by Spedding and Saeger and by this research, for the rare-earth chlorides, show a marked increase across the series, particularly at high concentrations. For example, the activity coefficients at 3.4 molal are: La(3.303) < Nd(3.822) < Sm(4.087) < Gd(4.836) < Dy(5.539) < Er(6.372) < Y(6.504). The osmotic and activity coefficients of yttrium chloride behave like those of the heavy rare-earth chlorides. The high activity coefficient of concentrated rare-earth chloride solutions strongly indicates that complete ionization of the electrolyte is far from being the case. The formation of complexes and polymerization of the electrolyte along with an increase in hydration, which decreases the water activity, all partly account for a high activity coefficient for the electrolyte. (auth)

13723 (ORNL-3341) THE PRODUCTION OF LiF SINGLE CRYSTALS WITH SELECTED ISOTOPIC RATIOS OF LITHIUM. C. F. Weaver, R. G. Ross, B. J. Sturm, J. E. Eorgan, and R. E. Thoma (Oak Ridge National Lab., Tenn.). Mar. 1964. Contract W-7405-eng-26. 47p.

Techniques and apparatus were developed to produce single crystals of LiF with selected ratios of the lithium isotopes containing not more than a few parts per million impurities. The starting material was prepared from purified aqueous solutions of LiOH and HF and was dehydrated in the molten state with anhydrous HF. The dehydrated LiF was then converted into a single crystal in a unique Stockbarger furnace which has a window allowing visual monitoring of the crystal growth and variable electrical shunts making possible the application or removal of thermal gradients at will. Crystals weighing several hundred grams and containing 99.99, 98.06, and 96.50 at. % lithium-7 have been produced as part of a sequence which will include 87.60, 79.28, 69.24, 50.77, and 0.7 at. % lithium-7. These crystals do not display strain under polarized light and do not show OH^- absorption of infrared radiation. The purest crystals produced contain less than 1 ppm cationic impurities according to the results of emission spectroscopy and neutron activation analysis. (auth)

13724 (ORNL-3537(p.106-7)) INORGANIC PREPARATIONS. M. T. Kelley, D. E. LaValle, and R. B. Quincy (Oak Ridge National Lab., Tenn.).

Numerous preparations of fused salts continued to be made. Some problems with the preparation of iodides still persisted. Preparations with rare-earth metals, as alloys with each other and in ternary oxide compounds with manganese, was continued. Some Fe^{57} compounds were also prepared. Anhydrous $ThCl_4$, $ZrCl_4$, and $AlCl_3$ were either prepared or purified. The study of the chemistry of rhenium did not lead to the discovery of any fluorides of rhenium lower than ReF_4, but several other compounds were characterized. The preparation of KCl of very high purity was accomplished. (auth)

13725 (TID-7676(p.154-62)) THERMAL DECOMPOSITION OF URANIUM CARBIDE. P. A. Vozzella, A. D. Miller, and M. A. DeCrescente (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown).

Data on the high-temperature vaporization behavior of uranium monocarbide in vacuum are presented. The cylindrical specimens were cold pressed and sintered from stoichiometric uranium carbide powder. Vaporization rates were determined by weighing the specimen before and after heating. The UC was found to vaporize congruently over the range 2010 to 2230°C. The rate varied from 2.0×10^{-6} g/cm²-sec at 2010°C to 38.3×10^{-6} g/cm²-cm at 2230°C. (M.C.G.)

13726 (TID-18650) PREPARATION AND PROPERTIES OF TWO STRONTIUM ORTHOPHOSPHATES: $Sr_3(PO_4)_2 \cdot 4H_2O$ AND $Sr_6H_3(PO_4)_5 \cdot 3H_2O$. Robert L. Collin (New England Deaconess Hospital. Cancer Research Inst., Boston). May 21, 1963. Contract AT(30-1)-901. 8p.

Preparation of $Sr_3(PO_4)_2 \cdot 4H_2O$ and $Sr_6H_3(PO_4)_5 \cdot 3H_2O$ is described. Strontium nitrate was added to mixtures K_2HPO_4 and KOH and KH_2PO_4 and KOH, respectively. X-ray-diffraction data are presented. (M.C.G.)

13727 (TID-20232) THERMODYNAMIC PROPERTIES OF SOLID SOLUTIONS AT HIGH TEMPERATURES. Prog-

ress Report, January 26, 1963–January 10, 1964. Arnulf Muan (Pennsylvania State Univ., University Park. Coll. of Mineral Industries). Jan. 10, 1964. Contract AT(30-1)-2781. 26p.

The activity-composition curves for cobalt and platinum in platinum–cobalt alloys at 1200 to 1400°C are given. The stability of fayalite, Fe_2SiO_4, is evaluated through the evaluation of the free energy of formation. Delineation of phase relations in the systems $CoO–SiO_2$ and $CoO–Fe_3O_4–SiO_2$ in air is accomplished. Activity-composition curve for the system MnO–FeO is discussed. Cation distribution between olivine- and periclase-type phases coexisting in equilibrium in the system $MnO–CoO–SiO_2$ is studied. Equilibria between pyroxene, silica, and metallic iron in the system Mg–Fe–Si–O, as a function of oxygen pressure, are evaluated. Equilibrium distribution of cations among olivine-, pyroxene-, and periclase-type solid solutions in the system $MnO–FeO–SiO_2$ is discussed. Cation distribution between spinel and manganowustite phases in the system Mn–Fe–O is being studied. (N.W.R.)

13728 (TRG-Report-708) THE EFFECTS OF DIFFUSIONAL CONTROL OF OXIDATION OF GRAPHITE ON THE HIGHEST SAFE TEMPERATURES IN AIR. P. J. Robinson (United Kingdom Atomic Energy Authority. Reactor Group, Windscale, Cumb., England). 1964. 30p.

The reaction of a gas with a porous solid can be restricted by the resistance to diffusion of gas through the pores. The magnitude of this restriction was quoted or derived for a series of simple geometrical shapes, and it is shown that an approximate treatment, based on a simplified model of the pore structure, gives results in close agreement with the rigorous treatments. The theory was applied to oxidation of the graphite blocks used in Calder reactors and in an experimental rig. Agreement with experimentally observed results was good, confirming the independent conclusion that possible errors in the treatment are relatively small. The disturbing influence of a bulk flow of gas through the graphite is shown to be negligible under reactor conditions. If air is admitted to a graphite-moderated reactor, the heat generated by oxidation of the graphite can give rise to a self-sustaining temperature rise. Previous theory, giving the conditions under which this could occur, was developed to allow for the effect of diffusional control of oxidation, and it is shown that this improves the agreement between the highest safe temperatures calculated for and observed in an experimental rig. (auth)

13729 (UCRL-7288) THE CLEAVAGES OF BeO AND OTHER MINERALS HAVING THE WURTZITE STRUCTURE. V. D. Frechette (New York. State Univ. Coll. of Ceramics, Alfred) and Carl F. Cline (California. Univ., Livermore. Lawrence Radiation Lab.). Mar. 20, 1963. Contract W-7405-eng-48. 6p.

A re-examination of cleavage behavior was conducted on five wurtzite-type compounds: BeO, ZnS, ZnO, CdS, and CdSe. The cleavages found are tabulated together with those of Dana and Wolff & Broder for comparison. The outstanding results are discussed, and possible reasons for the discrepancies are considered. (D.L.C.)

13730 (UCRL-11195) OPTICAL STUDIES OF ELECTROLYTE FILMS ON METAL SURFACES. Rolf H. Muller (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1964. Contract W-7405-eng-48. 4p. (CONF-407-1)

For Presentation at Electro Chemical Society, Toronto, May 1964.

The thickness of liquid films on metal electrodes, formed by partial withdrawal of polished flat and cylindrical metal surfaces from electrolytic solutions was measured by light interference. After a thinning period in the order of 10 hours, stationary film thicknesses in the order of 0.5 micron were observed with the exact values depending on the parameters of the system such as electrochemical polarization and electrolyte concentration. (auth)

13731 (USNRDL-TR-705) THE INFRARED SPECTRA OF RUBIDIUM BORATES OF VARYING COMPOSITION. J. T. Quan and C. E. Adams (Naval Radiological Defense Lab., San Francisco). Dec. 9, 1963. Contract AT(49-2)-1167. 29p.

The infrared transmission spectra of a series of rubidium borates consisting of varying proportions of rubidium oxide and boron oxide were studied in the 2.5 to 15.5 μ range. The rubidium oxide concentration varied from 4.2 to 50 mole %. Frequency assignments were made for molecular groups in these rubidium borates. The results can be interpreted to indicate that an increasing proportion of trigonally coordinated boron atoms in the borate glass network structure became tetrahedrally coordinated as the Rb_2O content was increased up to 33 mole %. This was accompanied by a simultaneous increase in the concentration of terminal $\geq B–O^-$ groups. Glasses containing Rb_2O in excess of 33 mole % tended to devitrify as boron reverted to trigonal coordination. At 50 mole %, the rubidium metaborate structure resembled that of sodium metaborate. Selected metal oxides, introduced into glasses of high Rb_2O content, entered into complex formation with $\geq B–O^-$ groups to reconstitute the network structure of the glass. (auth)

13732 (CEA-tr-R-1669) PREPARATION DE LA SOLUTION COLLOIDALE D'OR AVEC L'ISOTOPE ^{198}Au. (Preparation of a Colloidal Solution of Gold with Au^{198}). Translated into French. [nd]. 13p.

The step-by-step preparation of colloidal solutions of Au^{198}, beginning with the conversion of the metal into chloroauric acid followed by its reduction with ascorbic acid, is described. The apparatus, materials, and reagents used are tabulated. The characteristics of the final product are given, and the time necessary for the various steps in the preparation are cited. Safety precautions to be followed are indicated. (J.S.R.)

13733 THERMODYNAMIC PROPERTIES OF RARE EARTH COMPLEXES. II. FREE ENERGY, ENTHALPY AND ENTROPY CHANGES FOR THE FORMATION OF RARE EARTH DIGLYCOLATE AND DIPICOLINATE COMPLEXES AT 25.00°C. Ingmar Grenthe (Univ. of Lund, Sweden). Acta Chem. Scand., 17: 2487-98(1963).

The changes in free energy, enthalpy, and entropy for the formation of rare earth diglycolate and dipicolinate complexes were determined. All data for the diglycolate systems refer to a medium of the ionic strength I = 1.00 M and a temperature of 25°C. The data for the dipicolinate system refer to a medium of the ionic strength I = 0.50 M and a temperature of 25°C. The changes in free energy were computed from previously determined stability constants. The corresponding enthalpy changes were obtained from a direct calorimetric determination. The various entropy changes were computed by the use of the relation: $\Delta G_j^\circ = \Delta H_j^\circ - T \cdot \Delta S_j^\circ$. (auth)

13734 STUDIES ON THE HYDROLYSIS OF METAL IONS. 46. URANYL ION, UO_2^{2+}, IN CHLORIDE, PERCHLORATE, NITRATE, AND SULFATE MEDIA. SURVEY AND INTRODUCTION. Helen S. Dunsmore, Sirkka Hietanen, and Lars Gunnar Sillen (Royal Inst. of Tech., Stockholm). Acta Chem. Scand., 17: 2644-56(1963).

A survey is given of emf work on the hydrolysis of the UO_2^{2+} ion in the media 3 M (Na)Cl, 3 M $(Mg)ClO_4$, 3 M

$(Ca)ClO_4$, 3 M $(Na)ClO_4$, 1 M $(K)NO_3$, 1.5 M $(Na)SO_4$. MESAK diagrams of the average composition $(\bar{p},\bar{q})$ of the complexes $(UO_2)_q(OH)_p$ are given; they bear out the differences between the reactions in the various media. A survey of the best sets of the species and equilibrium constants obtained by LETAGROP refinement is presented. Equilibrium analysis leaves little doubt about the existence of the species (1,2), (2,2), (4,3) and (5,3), though their relative importance varies with the medium. The existence also of some higher members of the series (2 n, n + 1) is indicated, especially in sulfate medium. There is some evidence for the (1,1) complex. In NaCl medium another species, probably (7.4) is indicated. Complexing with the medium anion is discussed, obvious effects being the chloride complexing of the (4,3) complex, and the strong sulfate complexing of all species. (P.C.H.)

13735 STUDIES ON THE HYDROLYSIS OF METAL IONS. 47. THE URANYL ION IN 3M (Na)Cl MEDIUM. Helen S. Dunsmore and Lars Gunnar Sillén (Royal Inst. of Tech., Stockholm). Acta Chem. Scand., 17: 2657-63(1963).

The hydrolysis equilibria of UO_2^{2+} in 3 M (Na)Cl medium were studied at 25°C, using glass and quinhydrone electrodes. The best sets of equilibrium constants obtained by LETAGROP (generalized least-square) refinement, assuming various sets of complexes, together with the corresponding standard deviation of Z are given. As best set $\log \beta_{22} = -6.64 \pm 0.04$, $\log \beta_{43} = -12.54 \pm 0.08$, $\log \beta_{53} = -18.07 \pm 0.11$, $\log \beta_{64} = -19.96 \pm 0.21$, $\log \beta_{74} = -24.91 \pm 0.22$, where β_{pq} is the equilibrium constant of $qUO_2^{2+} + pH_2O \rightleftharpoons (UO_2)_q(OH)^{(2q-p)+} pH^+$ l was chosen. (P.C.H.)

13736 PROTON-MOBILITY IN THE INDENE RING-SYSTEM. III. KINETICS OF THE BASE-CATALYZED HYDROGEN EXCHANGE BETWEEN INDENE AND D_2O, AND THE EXISTENCE OF INTRAMOLECULAR PROTON-TRANSFER. Goeran Bergson (Uppsala Univ.). Acta Chem. Scand., 17: 2691-2700(1963).

Hydrogen exchange between indene and D_2O occurs at room temperature in pyridine solution with triethylamine as a catalyst. The exchange rate, obeying pseudo-first-order kinetics, was studied by the NMR-technique. The hydrogen atoms in the 1- and 3-positions of the indene molecule are substituted by deuterium, but in addition to this exchange reaction there is a rapid base-catalyzed proton-transfer between the 1- and 3-positions. The latter reaction could be studied separately using mono-deutero-indene. (auth)

13737 STUDIES ON THE HYDROLYSIS OF METAL IONS. 48. THE URANYL ION IN SODIUM, MAGNESIUM, AND CALCIUM PERCHLORATE MEDIUM. Sirkka Hietanen, B. R. L. Row, and Lars Gunnar Sillén (Royal Inst. of Tech., Stockholm). Acta Chem. Scand., 17: 2735-49 (1963).

The hydrolysis equilibria of UO_2^{2+} in the media 3 M $(Mg)ClO_4$, 3 M $(Ca)ClO_4$, and 3 M $(Na)ClO_4$ at 25°C were studied using glass and quinhydrone electrodes. The best sets of β_{pq} obtained by LETAGROP refinement, assuming various sets of species [p,q) with the corresponding standard deviations in Z are given. The best sets chosen are (1) for Mg and (2) for Ca perchlorate medium; both include the (1,2), (2,2), (4,3), and (5,3) species, the former also (6,4). For $NaClO_4$ medium, the sets (3) – (6) contain (1,2) (not important in this range), (2,2), (4,3), and (5,3). In addition, (4) contains (6,4), (5) contains an unlimited series (2n, n + 1), and (6) contains (1,1). (P.C.H.)

13738 THE ROTATIONAL SPECTRUM OF THE MOLECULES $S^{32}O^{16}O^{18}$ AND $S^{32}O^{18}O^{18}$ IN THE GROUND STATE. M. de Hemptinne, R. Van Riet, A. Defossez, F. Bruyninckx, and P. Dachelet (Centre de Physique Nucléaire et Moléculaire, Héverlé-Louvain, Belg.). Ann. Soc. Sci. Bruxelles, Ser. I, 77: 163-70(Dec. 20, 1963). (In French)

Some rotational lines of the ground-state molecules were identified that permitted determination, in a first order approximation, of the rotational constants and the centrifugal distortion coefficients. These values were used to recalculate the frequencies of the rotational transitions. The calculated values are in satisfactory agreement with the observed values, considering the approximation used. (tr-auth)

13739 ISOTOPIC EXCHANGE OF OXYGEN O^{18} WITH OXIDE CATALYSTS. Jana Nováková (Inst. of Physical Chemistry, Czechoslovak Academy of Sciences, Prague). Chem. Listy, 57: 797-802(Aug. 1963). (In Czech)

In studying the properties of oxide catalysts, oxygen enriched in O^{18} was contacted with the solid oxide. The rate of exchange R per unit area S is given by the following expression: $R = -[\ln(1 - F)n_s/(1 + \lambda)tS]$, where $F = [(\chi_0 - \chi)/(\chi_0 - \chi_\infty)]$, $\lambda = n_s/n_g$, χ_0 is the concentration of O^{18} in the gas phase at time $t = 0$, χ_∞ is the concentration of O^{18} in the gas phase at $t = \infty$, and n_s and n_g are the number of oxygen atoms in the solid phase and gas phase, respectively. The mechanism for heteromolecular and homomolecular exchange was taken into account. Recent exchange experiments with oxide catalysts showed three types of exchange reactions: the oxide catalyst did not participate in the reaction, the surface oxygen of the oxide catalyst participated in the reaction, and the reaction proceeded only by way of the oxide catalyst. Isotopic exchange was used to show the similarity in catalytic activity for the following oxides: V_2O_5, MnO_2, Co_3O_4, CuO, Cr_2O_3, Fe_2O_3, NiO, and ZnO. It was concluded that isotopic exchange of oxygen is an important method in characterizing oxide catalysts. (22 references). (TTT)

13740 COMPLEX TRIVALENT METALS OF THE THIRD GROUP OF THE PERIODIC SYSTEM. II. COMPLEX LANTHANUM COMPOUNDS. F. Vesely (Landwirtschaftliche Hochschule, Prague). Collection Czech. Chem. Commun., 29: 557-9(Feb. 1964). (In German)

Observations were made of the formation of complex ions in the systems $La^{3+} - HCOO^-$ or $La^{3+} - CH_3CH(OH)COO^-$ by paper iontophoresis. The mean values of the relative mobility of the lanthanum cations in solutions with different formate and lactate ion concentrations were determined. The results confirmed the assumption that the lanthanum cations form trinuclear complexes with monocarboxylic acid and mononuclear complexes with oxyacids. (M.C.G.)

13741 EVOLUTION OF THE DIFFUSION COEFFICIENTS OF Li^6, Na^{22}, AND K^{42} IN FUSED $KNO_3 - LiNO_3$ SYSTEMS. Frédéric Lantelme and Marius Chemla (College de France, Paris). Compt. Rend., 258: 1484-7 (Feb. 3, 1964). (In French)

The diffusion coefficients D_{Li}, D_{Na}, and D_K were determined in various $KNO_3 - LiNO_3$ mixtures, varying from 4 to 99% $LiNO_3$ by weight. The D_K/D_{Li}, D_K/D_{Na}, and D_{Na}/D_{Li} ratios thus measured are closer to unity than predicted by the Stokes-Einstein relation. This difference can be explained by the polyionic migration processes. The variation of the diffusion coefficients as a function of the composition of the mixture also confirms this hypothesis. (tr-auth)

13742 CHEMISTRY OF POLONIUM. Sen-lan Shia. Hua Hsueh Tung Pao, No. 1, 38-41(Jan. 1964). (In Chinese)

13743 THE FOG REACTOR CONCEPT AND SOME CONSIDERATIONS ON THE POSSIBILITIES OF ITS DEVELOPMENT. M. Silvestri and S. Viliani (Laboratori CISE, Milan). Energia Nucl. (Milan), 11: 34-8(Jan. 1964). (In Italian)

The fog-cooled reactor concept and that of an hypercritical-pressure, high-temperature reactor are mutually connected through intermediate steps. Some of these steps and the possibilities they offer are examined. (auth)

13744 ON THE IRREGULAR PROPERTY CHANGES OF RARE-EARTH ELEMENTS. G. A. Bandurkin (Kornakov Inst. of General and Inorganic Chemistry, Moscow). Geokhimiya, No. 1, 3-15(Jan. 1964). (In Russian)

An attempt was made to show irregularities in the change of some properties of rare-earth elements according to the atomic number. It is shown that deviations from the linear dependence exist in a number of physico-chemical properties and also in dimensional properties of the rare-earth elements. Most frequently the boundaries of structure change of rare-earth compounds of the boundaries stability–unstability, of rare-earth compounds fall on Nd, Ho, and Gd (accordingly — 29, 15, and 10 cases of 87 considered). These areas, conditionally named crystallochemical unstability areas, coincide with areas of maximum deviation and with the bending point on Gd. The quantitative quantum-mechanical analysis allows the suggestion that the above mentioned effects are conditioned by a strong spin-orbit interaction. A geochemical supplement of detected effects is given. It is shown that the selectivity of rare-earth element composition in compounds may be connected with the existence of crystallochemical unstability areas. (auth)

13745 ON URANIUM REDUCTION PROCESSES ON NATURAL ORGANIC MATTER. P. F. Andreev and A. P. Chumachenko. Geokhimiya, No. 1, 16-22(Jan. 1964). (In Russian)

On the basis of thermodynamical calculations and partly of experiments, a principal possibility was established for uranium VI to uranium IV reduction by active alcoholic and carbonyl groups entering into the composition of organic molecules. Reduction with the aid of hydrocarbons is not very likely. The process of formation of natural uranium–organic associations begins with the stage of rise of intracomplex compounds of uranium with carbonyl a. o. active groups within which later on pass processes of uranium ions reduction and organic matter oxidation. The formation of uranium blacks in nature is not always connected with the reducing effect of hydrogen sulfide as no formation of sulfide ions or of hydrosulfide from sulfate ions was observed in the experiments. (auth)

13746 THERMOGRAVIMETRIC AND DIFFERENTIAL THERMAL ANALYSIS STUDY OF THE LOW TEMPERATURE OXIDATION OF UO_2. V. V. Deshpande, R. P. Saxena, S. H. Daroowalla, and M. D. Karkhanavala (Atomic Energy Establishment, Trombay, India). Indian J. Chem., 1: 511-13(Dec. 1963).

Low temperature oxidation of UO_2 from different source materials was studied by thermogravimetric and differential thermal analyses. The results obtained by both the methods confirm previous findings that low temperature oxidation proceeds in two steps, $UO_2 \rightarrow U_3O_7 \rightarrow U_3O_8$. The results also indicate a marked influence of the source material and the temperature of preparation on the oxidation behavior of UO_2. (auth)

13747 URANIUM(IV) OXYCOMPLEXES. B. Sahoo (M.P.C. Coll., Baripada, Mayurbhanj, India). Indian J. Chem., 2: 75-6(Feb. 1964).

Uranium(IV) oxyformate complexes with ammonium, sodium, and potassium formates, prepared by a photolytic method, were found to possess the formulas $UO(HCOO)_2 \cdot NH_4(HCOO)$, $2UO(HCOO)_2 \cdot Na(HCOO) \cdot H_2O$, and $2UO(HCOO) \cdot K(HCOO) \cdot H_2O$, respectively. An ammonium acetate complex having the formula $2UO(CH_3COO)_2 \cdot NH_4(CH_3COO)$ was also isolated. All these complexes are nonhygroscopic and thermally unstable. (auth)

13748 THE ABSORPTION SPECTRA OF LIQUID PHASE H_2O, HDO AND D_2O FROM 0.7 μm TO 10 μm. J. G. Bayly, V. B. Kartha, and W. H. Stevens (Atomic Energy of Canada Ltd., Chalk River, Ont.). Infrared Phys., 3: 211-23(Dec. 1963).

The H_2O infrared spectrum is based on that of natural water, the D_2O spectrum on that of heavy water containing approximately 99.6 weight per cent D_2O. The HDO infrared spectrum was deduced from spectra of H_2O–HDO–D_2O mixtures by application of Beer's law. The spectra are presented in terms of logarithms of both an extinction length, L, the sample thickness that has unit optical density, and the molecular extinction coefficient, ϵ, plotted against logarithms of both wavelength and wave number. Vibration mode assignments were made for most of the absorption bands observed. The spectral data obtained are useful in the development of infrared monitoring instrumentation and methods of analysis for H_2O–HDO–D_2O mixtures in connection with heavy water reactor research programs. (auth)

13749 STUDIES OF THE AMMONIUM FLUORIDE–URANIUM TETRAFLUORIDE–WATER SYSTEM. PROPERTIES OF $(NH_4)_4UF_8$, $(NH_4)_2UF_6$, $7NH_4F \cdot 6UF_4$, AND OF U(IV) IN AQUEOUS NH_4F. R. A. Penneman, F. H. Kruse, R. S. George, and J. S. Coleman (Los Alamos Scientific Lab., N. Mex.). Inorg. Chem., 3: 309-15 (Mar. 1964). (LADC-5941)

Emerald-green $(NH_4)_4UF_8$ is the solid phase in equilibrium at 25° with aqueous solutions containing from 24.2 wt % NH_4F to 45.1 wt % (saturated) NH_4F. Its solubility in this range is given in terms of molalities by $[U(IV)] = 665[NH_4F]^{5-} + 0.00465[NH_4F]^{9}$. From solutions less concentrated than 24.2 wt % NH_4F, the lower complexes $(NH_4)_2UF_6$ and $7NH_4F \cdot 6UF_4$ are obtained, but $(NH_4)_3UF_7$ is not observed. $(NH_4)_2UF_6$ is polymorphic, exhibiting four crystalline modifications near room temperature. The form in equilibrium with NH_4F solutions at 25°C is orthorhombic γ-$(NH_4)_2UF_6$, space group $Pmc2_1$ or $Pmcm$, $a_0 = 4.05$, $b_0 = 7.03$, $c_0 = 11.76$ Å, $Z = 2$. The visible spectra of U(IV) in solution show marked changes with the NH_4F concentration and some sensitivity to the U(IV) concentration. Fluoride-form anion exchanger absorbs up to 0.60 mole of UF_4 per equivalent of exchange capacity. (auth)

13750 THE FORMATION OF A NEPTUNIUM(V)–CHROMIUM(III) COMPLEX. KINETICS AND EQUILIBRIA IN PERCHLORATE SOLUTIONS. James C. Sullivan (Argonne National Lab., Ill.). Inorg. Chem., 3: 315-19(Mar. 1964).

A value for the equilibrium quotient $Q = [Np(V) \cdot Cr(III)]/[Np(V)][Cr(III)]$ of 2.62 ± 0.48 at 25°C was determined spectrophotometrically. Values of $\Delta H = -3.3 \pm 0.6$ kcal and $\Delta S = -9.0 \pm 1.9$ eu were determined. The rates of formation and aquation of the complex Np(V) · Cr(III) were measured. The complex is also formed by the reduction of Np(VI) with Cr(II). (auth)

13751 CARBONATE AND BICARBONATE COMPLEXES OF NEODYMIUM AND EUROPIUM. Howard

S. Sherry and Jacob A. Marinsky (State Univ. of New York, Buffalo). Inorg. Chem., 3: 330-5(Mar. 1964).

The distribution of Eu(III) and Nd(III) between Dowex I-X8 and solutions of $KHCO_3$ and K_2CO_3 was studied as a function of salt concentration in order to elucidate their complexing behavior in the presence of the inorganic ligands. Equilibration and chromatographic techniques were employed using radioactive isotopes of Eu and Nd to facilitate the investigation. The distribution of tracer S^{35} in the form of $S^{35}O_4^{2-}$ between Dowex I-X8 and solutions of $KHCO_3$ and K_2CO_3 was studied to determine the effect of imbibed electrolyte and changing internal and external activity coefficents. Analysis of the data indicates that imbibement and activity coefficient corrections are negligible over the concentration range that is covered, thus giving an experimental basis for a portion of the data. Distribution coefficients were measured over the concentration range of 0.0010 to 1.00 M K_2CO_3 and $KHCO_3$. Over this region a logarithmic plot of the distribution coefficient vs the logarithm of salt molality ($KHCO_3$ or K_2CO_3) resulted in curves that were analyzed for the complex species that exist in solution and their stepwise formation constants. Computer methods were used to facilitate the calculations. Analysis of the $KHCO_3$ systems indicates the presence of the di-, tetra-, penta-, and heptabicarbonato complexes. A similar analysis of the K_2CO_3 systems indicates the presence of the dicarbonato, tricarbonato, and tetracarbonatohydroxo complexes. Inherent weaknesses in the mode of analysis are detailed so that the possibility of error in the interpretation of the data that is presented is understood. (auth)

13752 VAPOR PRESSURES OF ZIRCONIUM TETRACHLORIDE ABOVE SODIUM CHLORIDE AND SODIUM HEXACHLOROZIRCONATE(IV). B. G. Korshunov and N. W. Gregory (Univ. of Washington, Seattle). Inorg. Chem., 3: 451-4(Mar. 1964).

A study was made of decomposition pressures of $ZrCl_4$ above solid mixtures of NaCl and Na_2ZrCl_6 between 300 and 525°K. The results indicate that decomposition pressures are independent of the relative amounts of NaCl and Na_2ZrCl_6 present. In one type of experiment the composition of the solid remained close to pure NaCl; in another the solid phase contained around 50 mole % NaCl. The data suggest a possible transition in the vicinity of 390 to 400°K. Equilibrium data are tabulated. (P.C.H.)

13753 BORON HYDRIDES. VII. THE METAL ION CATALYZED HYDROLYSIS OF SODIUM BOROHYDRIDE IN HEAVY WATER. Robert Earl Davis, Judith Ann Bloomer, David R. Cosper, and Afif Saba (Purdue Univ., Lafayette, Ind.). Inorg. Chem., 3: 460-1(Mar. 1964).

It is reported that changes in isotopic composition in the hydrolysis of sodium borohydride in heavy water are due to metal ion catalyzed reactions and that micromolar amounts of heavy metals will greatly change the composition of the gas. Results with Co, Pd, and Pt are given. One microgram of Co can reduce the amount of HD from 98 to 82%. The catalytic effect of the preformed Co catalyst finally levels off at 64%. (P.C.H.)

13754 LIQUID-VAPOR EQUILIBRIUM IN THE SYSTEM NORMAL HYDROGEN–HELIUM. W. B. Streett, R. E. Sonntag, and G. J. Van Wylen (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 40: 1390-5(Mar. 1, 1964).

Liquid-vapor equilibrium phase compositions for the binary system normal hydrogen–helium were determined for 11 isotherms in the range 15.5°–32.50°K and at pressures up to 500 psia. The vapor recirculation method of obtaining equilibrium was used in conjunction with a liquid hydrogen vapor-pressure controlled cryostat. Analyses were made on a mass spectrograph. The results are presented in both tabular and graphical form, and the general behavior of the system discussed. An agreement with some previous investigations is demonstrated, and conflicts in existing data are resolved. Some problems of theoretical correlation of the data are discussed. (auth)

13755 APPLICATION OF EMANATION METHOD TO PSEUDOMORPHOUS IRON HYDROXIDE. H.-H. Stamm and H. W. Kohlschuetter (Technische Hochschule, Darmstadt, Ger.). J. Inorg. Nucl. Chem., 26: 247-51(Feb. 1964). (In German)

Application of the emanation method to pseudomorphous iron(III) hydroxide is described. A suitable incorporation of Th^{228} into solid hydroxide was investigated. As a function of temperature the emanating power was measured. The effect of preheating as well as the influence of small amounts of silicate on the heating curves were determined. (auth)

13756 STUDIES ON THE TRI-n-OCTYLPHOSPHINE OXIDE COMPLEX OF URANYL NITRATE. A. H. A. Heyn and Y. D. Soman (Boston Univ.). J. Inorg. Nucl. Chem., 26: 287-95(Feb. 1964).

The stoichiometry of the tri-n-octylphosphine oxide (TOPO) complex of uranyl nitrate was established by extraction studies. On the basis of these studies, the formula $UO_2(NO_3)_2(TOPO)_2$ can be assigned to the complex. The complex possesses a high degree of stability. Approximate values of ΔH, ΔF, and ΔS were obtained at 25°C for the extraction reactions of uranyl nitrate and nitric acid into TOPO-cyclohexane. The complex was found to be labile with respect to uranium exchange and possesses a dipole moment of about 8 Debye units. The molecular weights of the complex in cyclohexane and benzene were found to be significantly different. The spectra of the complex were obtained in the visible and the infrared regions (5000–700 cm^{-1}; 2–15 μ). (auth)

13757 SYNTHETIC INORGANIC ION-EXCHANGE MATERIALS. IV. EQUILIBRIUM STUDIES WITH MONOVALENT CATIONS AND ZIRCONIUM PHOSPHATE. C. B. Amphlett, P. Eaton, L. A. McDonald, and A. J. Miller (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. Nucl. Chem., 26: 297-304(Feb. 1964).

Equilibrium studies with zirconium phosphate and 0.1 N solutions containing pairs of cations showed that the systems Cs^+/Rb^+ and Cs^+/K^+ give normal rectilinear isotherms, while S-shaped curves are obtained for exchange between H^+ ions and either Cs^+ or Rb^+ ions, with pronounced reversal of selectivity. This behavior is tentatively ascribed to steric factors that may arise when the exchanging ions differ appreciably in size. Values are given for the free energies of the exchange reactions, and in the Rb^+/H^+ and Cs^+/H^+ systems for the heats and entropies also. (auth)

13758 THE EXCHANGE OF CAESIUM AND HYDROGEN IONS ON ZIRCONIUM PHOSPHATE. J. P. Harkin, G. H. Nancollas, and R. Paterson (Glasgow Univ.). J. Inorg. Nucl. Chem., 26: 305-10(Feb. 1964).

The equilibrium exchange of cesium and hydrogen ions with the hydrogen and cesium form respectively of zirconium phosphate at a constant ionic strength of 0.10 M was studied at 25 and 45°C. From the sigmoid exchange isotherms, thermodynamic equilibrium constants were cal-

culated for the exchange $RH + Cs^+ \rightleftharpoons RCs + H^+$ where R represents the zirconium phosphate matrix. (auth)

13759 ABSORPTION AND FLUORESCENCE SPECTRA OF Eu^{2+} IN ALKALI HALIDE CRYSTALS. R. Reisfeld and A. Glasner (Hebrew Univ., Jerusalem). J. Opt. Soc. Am., 54: 331-3(Mar. 1964).

Alkali halide crystals and pressed disks doped with divalent europium were prepared and their absorption and fluorescence spectra measured. There are two broad absorption bands in the ultraviolet, peaking at ~250 and 330 mμ, both due to the transition $4f^7 \rightarrow 4f^6 5d^1$, and attributed, after comparison with the absorption spectra of Eu^{2+} observed in various other media, to the splitting of the 5d orbitals by the crystal field. In addition to the many sharp bands riding on the main absorption bands, one peaking at 270 mμ has been observed, in complete analogy with the Gd^{3+} spectrum. The fluorescence emission spectra are identical, irrespective of the wavelength of irradiation (250 or 330 mμ). (auth)

13760 ON THE HYDROGEN EXCHANGE BETWEEN DEUTERIUM AND AMMONIA CATALYZED BY EVAPORATED NICKEL FILM. Koshiro Miyahara. J. Res. Inst. Catalysis, Hokkaido Univ., 11: 129-31(Nov. 1963).

The results of a previous experiment (Miyahara, Ozaki, and Kimura. J. of Res. Inst. for Catalysis 11, 124, 1963) on the hydrogen exchange between deuterium and ammonia catalyzed by evaporated nickel film are evaluated and discussed. (P.C.H.)

13761 COMPATIBILITY OF URANIUM DIOXIDE AND ALUMINUM. 2. STUDIES ON UO_2–Al REACTION INHIBITION IN DISPERSION-TYPE FUEL ELEMENTS. H. E. Roellig (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 7: 11-18(Jan. 1964). (In German)

An investigation of the inhibition of the UO_2–Al reaction in pressed powder is reported. Oxide-free pure aluminum, Al–Si systems, and ASW powder with ~10% oxide content were used. The effectiveness of oxide and nitride layers on the aluminum, the influence of the silicon content in aluminum, and the influence of the thermal deactivation of the uranium dioxide on the reaction were investigated. The strongest inhibiting effect was obtained with aluminum nitride layers, which were produced of aluminum powder with nitrogen under reduced pressure. The inhibition phenomena are discussed. (tr-auth)

13762 PRODUCTION OF ELEMENTARY SULFUR-35. M. Kucharski and R. Plejewski (Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw). Kernenergie, 7: 41-2(Jan. 1964). (In German)

A method for the preparation of labeled elementary sulfur is described, in which irradiated KCl serves as the starting material. The $S^{35}O_4^{2-}$ ions present in the irradiated target were first reduced to $[S^{35}]^{2-}$ and then further to elementary sulfur. As an end product a benzene solution, or, after evaporation of the benzene, sulfur crystals, were obtained. (tr-auth)

13763 SOME THERMODYNAMIC PROBLEMS INVOLVED IN THE REDUCTION OF RARE METAL OXIDES. Yuan-xi Tsen. Kexue Tongbao, No. 1, 30-3(1962). (In Chinese)

The solubility of O in the reduced metal is the main reason for the influence of certain halides in the case of the reduction of rare metals. By analogy with reactions observed in ferrous metallurgy, the reoxidation by means of the dissolved O may be expressed as follows: $yO + zM \rightleftharpoons M_zO_y$, producing the equilibrium conditions expressed as $[a_M]^z[a_O]^y = K$, or: $[wt.\%M]^z[wt.\%O]^y = K'$. Graphs were prepared with wt % O as ordinates versus wt % M as abscissa for V, Ti, and Th, with Al or Ca as the reducing agent. It was found in all these cases that the logarithmic plots are not straight lines, thus indicating reoxidation and occlusion of oxygen which results in the formation of impure products. (TTT)

13764 SLOW NEUTRON SCATTERING BY BENZENE MOLECULES. Franciszek Maniawski and Krzysztof Parlinski (Inst. of Nuclear Physics, Krakow). Nukleonika, 8: 581-6(1963).

The total neutron scattering cross section per proton bound in the benzene molecule was measured. The results were compared with other total neutron cross section calculations. The angular distribution of scattered neutrons by benzene molecules was also measured. (auth)

13765 DETERMINATION OF THE OPTICAL PARAMETERS OF THE γ PHASE OF CERIUM SULFIDE. S. W. Kurnick and C. Meyer (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Chem. Solids, 25: 115-21(Jan. 1964).

The optical parameters of the γ phase of cerium sulfide were measured to determine the magnitude of Fröhlich's coupling parameter, $\alpha = e^2(1/\epsilon_\infty - 1/\epsilon_0)(m/2\omega\hbar^3)^{1/2}$, which determines the strength of the interaction between a conduction electron and the polar lattice. The interaction is sufficiently great as to expect polaron-type corrections to the effective mass and mobility, particularly at the sulfur-rich extreme of the stoichiometric range. (auth)

13766 EFFECTS OF GAS MEDIA ON CERIUM AND YTTRIUM PRECIPITATION WITH CaF_2 CRYSTALLIZED FROM A CaF_2–NaF BINARY SYSTEM. K. G. Myakishev and V. R. Klokman. Radiokhimiya, 5: 527-36(1963). (In Russian)

Coefficients for CeF_3 and YF_3 distribution between the system and CaF crystals in oxygen, carbon dioxide, argon, and nitrogen media were determined. Coefficients for CeF_3 and YF_3 in oxygen and carbon dioxide were smaller in argon and nitrogen. Coefficient variations with temperature and time in the solid state resulted from reduced compound strengths and changes in the gas solubilities. (R.V.J.)

13767 MAGNETIC MOMENTS OF U(IV) IONS IN AQUEOUS SOLUTIONS. V. M. Vdovenko, G. A. Romanov, and V. A. Shcherbakov. Radiokhimiya, 5: 574-81(1963). (In Russian)

The static magnetic moment of U(IV) ions in perchloric solution was measured, and the proton spin-lattice relaxation time in the presence of various anions was determined. Effective magnetic moments of U(IV) in various media were also determined. The spin-lattice electron relaxation time in U(IV) ions does not exceed 10^{-11} sec. Both unpaired electrons in the U(IV) electron shell are in the 5f state. The dependence of the effective magnetic moment magnitudes on the composition of the medium indicated a new way of investigating U(IV) complexing with NO_3^-, Cl^-, and SO_4^{2-} anions by means of proton resonance. (R.V.J.)

13768 STUDIES OF COMPLEX FORMATION OF URANIUM(IV) WITH FLUORIDE ION BY MEANS OF PROTON RESONANCE. V. M. Vdovenko, G. A. Romonov, and V. A. Shcherbakov. Radiokhimiya, 5: 581-5(1963). (In Russian)

The complexing of U(IV) with fluoride ion in aqueous solution was investigated using the proton resonance method. An effective increase of the uranium magnetic moment (μ_{eff}) was observed during the formation of a complex (UF^{3+}) resulting from the spallation of lower orbital levels. Complexing of $[UF_2^{2+}]$ and $[UF_3^+]$ is followed by a stepwise re-

ducing of uranium(IV) μ_N. The function $1/T_1$ (T_1 = spin-lattice relaxation time) of tetravalent uranium solutions analyzed as a function of F-ion concentration was used for calculating stability constants of $[UF^{3+}]$, $[UF_2^{2+}]$, and $[UF_3^{+}]$. Stability constants of $[UF_4]$ were estimated using an extrapolation method. (R.V.J.)

13769 SPECTROPHOTOMETRIC INVESTIGATION OF UO_2Cl_2 SOLVATION BY ORGANIC PHOSPHORUS COMPOUNDS. V. M. Vdovenko, A. A. Lipovskii, and S. A. Nikitina. Radiokhimiya, 5: 585-91(1963). (In Russian)

Spectrophotometric analysis shows that solutions of disolvates of UO_2Cl_2 saturated by molecules of TBP (tri-n-butylphosphate), DBEBP (di-n-butyl ester of n-butylphosphinic acid), BEDBP (n-butyl ester of di-n-butylphosphinic acid), and TBPO (tributylphosphine oxide) form $UO_2Cl_2 \cdot 3S$ solvates. In contrast to the established concept, the coordination number of uranyl in UO_2Cl_2 with neutral admixtures is 5. Measurements of the infrared absorption spectra indicate that the absorption band of the valence oscillations in the P = O group, bonded with uranium atoms, shifts toward large wave numbers during the formation of the $UO_2Cl_2 \cdot 3S$ solvate. This shift was interpreted as an indication of a weak bond between the admixtures and the uranium atoms in $UO_2Cl_2 \cdot 3S$ solvates. (R.V.J.)

13770 SOLID PHASE IN $UO_2(NO_3)_2-K_2CO_3-H_2O_2-H_2O$ SYSTEM. A. M. Gurevich and L. P. Polozhenskaya. Radiokhimiya, 5: 592-602(1963). (In Russian)

Results are presented of the investigation of the solid phase in the system $UO_2(NO_3)_2-K_2CO_3-H_2O_2-H_2O$, and the formation of a series of complexes was analyzed. A complexing scheme for the system at pH 8.5 to 10 was suggested. The strong bond of the peroxide group with the uranyl group showed that the displacing force of the O_2^{2-} ion is the strongest among the addends. (R.V.J.)

13771 EFFECTS OF Fe(III) ION SOLUTIONS ON DISSOLUTION OF URANIUM DIOXIDE. E. A. Kanaevskii and A. P. Filippov. Radiokhimiya, 5: 602-8(1963). (In Russian)

Dissolution of UO_2 in various concentrations of sulfuric acid (from pH = 3.5 to a concentration of H_2SO_4 of 200 g/l) at 25°C was studied using Fe^{3+} (0.0741 M) as an oxidizing agent. The solubility curve of UO_2 as a function of pH showed a maximum at pH = 1.5. It was shown that the hydrolyzed ions, $FeOH^{2+}$, $Fe(OH)_2^{+}$, and $Fe_2(OH)_2^{4+}$, play the paramount part in the dissolving process while Fe^{3+} ions possess a certain oxidizing activity. (R.V.J.)

13772 APPLICATION OF ION EXCHANGE TO STUDIES OF SUBSTANCE STATE IN SOLUTION. X. STUDIES OF EUROPIUM AND TERBIUM COMPLEXES WITH LACTIC ACID. V. I. Paramonova and L. V. Solntseva. Radiokhimiya, 5: 608-16(1963). (In Russian)

Studies of europium and terbium complexing with lactic acid at 1×10^{-3} to 3.98×10^{-2} M showed the existence of $[MA]^{2+}$ at an acid concentration of 1×10^{-3} to 3.2×10^{-3} M; $[MA_2]^{+}$ at 3.2×10^{-3} to 9.6×10^{-3} M, and $[MA_3]^{0}$ at 9.6×10^{-3} to 4×10^{-2} M. The instability constants for the Eu complexes were: $K_{1-0} = 3.7 \times 10^{-3}$, $K_{2-0} = 2.6 \times 10^{-5}$; and $K_{3-0} = 4.8 \times 10^{-6}$, while the stepwise instability constants were: $K_{1-0} = 3.7 \times 10^{-3}$, $K_{2-1} = 7 \times 10^{-3}$, and $K_{3-2} = 1.86 \times 10^{-1}$. The Tb complexes with lactic acid at acid concentration from 8.6×10^{-4} to 4.3×10^{-2} M were: $[MA]^{2+}$ at 8.6×10^{-4} to 3.99×10^{-3} M; $[MA_2]^{+}$ at 3.99×10^{-3} to 9.6×10^{-3} M, and $[MA_3]^{0}$ at 9.6×10^{-3} to 4.35×10^{-2} M. The instability constants for the Tb complexes were: $K_{1-0} = 3.0 \times 10^{-3}$, $K_{2-0} = 4.1 \times 10^{-5}$, and $K_{3-0} = 7.7 \times 10^{-6}$, and the stepwise instability constants were calculated as: $K_{1-0} = 3.0 \times 10^{-3}$ $K_{2-1} = 1.35 \times 10^{-2}$, and $K_{3-2} = 1.88$. (R.V.J.)

13773 SEPARATION OF SAMARIUM FROM NEODYMIUM AND PRASEODYMIUM BY ELECTROLYSIS ON A MERCURY CATHODE. V. P. Shvedov and P. G. Antonov. Radiokhimiya, 5: 616-18(1963). (In Russian)

The optimum conditions for the separation of Sm from Nd and Sm from Pr were found to be electrolysis with a 1.34 M concentration of lithium tartrate as complexing agent and a current density of 15.5 ma/cm^2 for 60 min at 20°C. It was shown that under the above conditions 100% of the Sm, 1 to 2% of the Nd, and 2 to 3% of the Pr transfer into the mercury phase. (R.V.J.)

13774 BEHAVIOR OF C^{14} RECOIL ATOMS IN MIXTURES OF PYRIDINE WITH BENZENE AND CYCLOHEXANE. E. N. Avdonina, K. Mudra, and A. N. Nesmeyanov. Radiokhimiya, 5: 633-5(1963). (In Russian)

The behavior of C^{14} recoil atoms in pyridine mixtures with benzene and cyclohexane showed an improved radiation stability and radiochemical yield of certain products taking place with an increase of scattering energy in the system. The stabilization of the C^{14} recoil atom results from the $C^{14}-C$ bond and not from the $C^{14}-H$ bond, expressed by reduced molecular weight, low initial molecular retention and absence of labeled methane. (R.V.J.)

13775 APPLICATION OF MICROAUTORADIOGRAPHY IN THE INVESTIGATION OF RADIUM DIFFUSION IN FILMS OF HIGH MOLECULAR WEIGHT SUBSTANCES. K. B. Zaborenko, D. Nittsol'd, and V. I. Korobkov. Radiokhimiya, 5: 642-3(1963). (In Russian)

Microautoradiographic studies of radium distribution in polyvinyl alcohol, poly-ε-caprolactam, and polyethyleneterephthalate showed that a considerable accumulation of Ra^{244} isotopes are evenly distributed. Such accumulations are rare in polyvinyl alcohol and poly-ε-caprolactam but are quite common in polyethyleneterephthalate. (R.V.J.)

13776 THE ABSORPTION ISOTHERM FOR THE HYDRIDE PHASE OF TRANSITION METALS. Romulus V. Bucur (Inst. of Atomic Physics, Cluj, Rumania). Rev. Phys., Acad. Rep. Populaire Roumaine, 8: 395-409(1963). (In German)

An empirical equation for calculation of the solubility limits, the heat of absorption, and entropy of absorption of hydrogen in metals from experimental results with respect to composition, temperature, and pressure was expanded to include the transition metals. Limiting values for temperature-dependent compositions in the following metal-hydrogen systems were obtained: Pd-H, V-H, Nb-H, Ta-H, Ti-H, Zr-H, Hf-H, Y-H, Ce-H, Gd-H, Th-H, U-H, and Pu-H. The calculated values were compared with thermochemical and thermodynamic determinations and literature values. (M.C.G.)

13777 CONDUCTOMETRIC AND RADIOMETRIC STUDIES ON THE COMPOSITION OF MERCURIC FERROCYANIDE. Antoni Basiński, Wojciech Szymański, Alicja Krygier, and Gabriela Zapałowska (N. Copernicus Univ., Toruń, Poland). Roczniki Chem., 37: 1345-50(1963).

Conductometric and radiometric titrations of mercuric nitrate and chloride with solutions of potassium and lithium ferrocyanides were carried out. The formation of numerous mixed and double salts of alkaline ferrocyanides with mercuric salts was confirmed. (auth)

13778 XENON TETROXIDE: MASS SPECTRUM. John L. Huston (Loyola Univ., Chicago), Martin H. Studier, and Eric N. Sloth. Science, 143: 1161-2(Mar. 13, 1964).

The spectrum of XeO_4 is reported. The typical isotope

pattern of Xe is repeated every 16 mass units up to XeO_4. The exact mass of the tetroxide was verified further by reference to the spectrum of Hg. The fragmentation pattern varied very little with the energy of the ionizing beam of electrons. The volatility of XeO_4 was demonstrated by its very rapid distillation when a liquid nitrogen bath was replaced by one of dry ice. (P.C.H.)

13779 MEASUREMENT OF THE MEAN SPECIFIC HEAT OF REFRACTORY MATERIALS. P. Robijn. Silicates Ind., 28: 247-53(May 1963). (In French)

The apparatus and operating details for measuring the mean specific heat of a range of refractory materials at temperatures from 500 to 1300°C are described, for four types of refractory: fusion cast, siliceous clays, and basic materials. Results are interpreted according to the values of the four oxides, SiO_2, Al_2O_3, MgO, and ZrO_2. Finally an anomaly encountered when making measurements of the mean specific heat of a zircon fusion-cast refractory is also described. (TCO)

13780 COMPLEXES OF IMPURITY IONS IN STRONTIUM CHLORIDE CRYSTALS. M. I. Kornfel'd and L. S. Sochava (Semiconductor Inst., Leningrad). Soviet Phys.-Solid State (English Transl.), 5: 1625-7(Feb. 1964).

The EPR spectra of Mn^{2+} ions introduced into a strontium chloride single crystal (~0.1 at. %) were investigated at a frequency of 9.35 kMc. The axial symmetry of the spectra indicates the formation of complexes from Mn^{2+} and a point defect located in one of the nearest anionic nodes. A pronounced angular dependence of line intensities in the indicated spectra was found. (auth)

13781 THERMODYNAMICS OF IRON OXIDES. M. S. Yakovleva and S. M. Ariya. Vestn. Lenningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 130-2(1963). (In Russian)

By emf measurements of galvanic cells, containing FeO_{1+x}, it was shown that FeO_{1+x} is not an adiathermal solid solution of two iron oxides. (auth)

13782 THERMOGRAPHIC INVESTIGATION OF THE SYSTEMS RbCl–$NbOCl_3$ AND CsCl–$NbOCl_3$. S. A. Shchukarev, E. K. Smirnova, and I. V. Vasilkova. Vestn. Lenningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 132-3 (1963). (In Russian)

In the RbCl–$NbOCl_3$ and CsCl–$NbOCl_3$ systems by means of the thermographic analysis, the compound formation of three types was found. The compound RbCl · $NbOCl_3$ melts congruently at 526°C and that of CsCl · $NbOCl_3$ melts incongruently at 455°C. The congruently melting compounds 2RbCl · $NbOCl_3$ and 2CsCl · $NbOCl_3$ have the melting points equal to 616° and 642°C, respectively. Formed in the solid state are the compounds 3RbCl · $NbOCl_3$ and 3CsCl · $NbOCl_3$ that are decomposed at above 546° and 520°C, respectively. (auth)

13783 COMPLEX FORMATION OF PROTACTINIUM (V) WITH SULFATE AND NITRATE IONS. J. Nowikow and G. Pfrepper (Inst. für Angewandte Radioaktivitat, Leipzig and Vernadskii Inst. for Geochemistry and Analytical Chemistry, Moscow). Z. Naturforsch., 18b: 993-1001(Dec. 1963). (In German)

Stability constants of the complexes of Pa(V) with HNO_3 and H_2SO_4 at concentrations of the complex former of 0.05 to 1.0 mol/l were measured by the ion exchange method using Pa^{233} as indicator. Pa(V) formed several complexes with HNO_3, of those, the 1:1, 1:2, and 1:4 complexes could be identified and measured. With H_2SO_4 1:1 and 1:2 complexes were formed. The complexes had a neutral or anionic character, with, according to the results attained, the anionic complexes dominating. (tr-auth)

13784 THORIUM RHODANATE COMPOUNDS. A. K. Molodkin and G. A. Skotnikova (Kurnokov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 9: 60-9(Jan. 1964). (In Russian)

The existence of a family of thorium aquorhodanate compounds has been confirmed by the preparation of the complexes: $[Th(NCS)_4(H_2O)_4]$; $Rb[Th(NCS)_5(H_2O)_3]$; $(NH_4)_3[Th(NCS)_7 H_2O] \cdot nH_2O$, n = 4,6; $K_4[Th(NCS)_8] \cdot 3.5 H_2O$; $Rb_4[Th(NCS)_8] \cdot 2H_2O$; $Cs_4[Th(NCS)_8] \cdot 2H_2O$; and $(NH_4)_4[Th(NCS)_8] \cdot 2H_2O$. Various properties of the compounds were studied including the molecular electric conductivity of aqueous and methanol solutions and the thermal stability. (R.V.J.)

13785 COMPLEX COMPOUNDS OF TRI- AND PENTAVALENT MOLYBDENUM WITH THIOUREA. Vikt. Spitsyn, I. D. Kolli, and Wen-hsia T'am (Moscow State Univ.). Zh. Neorgan. Khim., 9: 99-105(Jan. 1964). (In Russian)

Studies of the synthesis and stability of complexes tri- and pentavalent molybdenum with thiourea $[Mo(thio)_3 Cl_3]$, $[Mo_2O_3(thio)_8]Cl_4$, and $[Mo_2O_3(thio)_8]Br_4$ showed that the compounds are quite stable and have identical electric conductivity. Decomposition begins at 180°C on heating. (R.V.J.)

13786 BEHAVIOR OF ZIRCONIUM DIOXIDE IN MOLTEN POTASSIUM FLUOBORATE. P. A. Polishchuk (Dnepropetrovsk Inst. of Chemistry and Tech., USSR). Zh. Neorgan. Khim., 9: 147-51(Jan. 1964). (In Russian)

The solubility of zirconium dioxide in molten potassium fluoborate was studied. The fluorination of ZrO_2 by boron trifluoride takes place in the presence of potassium fluoride according to the following reaction: $9KF + 4BF_3 + 3ZrO_2 \rightarrow 3K_3ZrF_7 + 2B_2O_3$. The reaction of ZrO_2 with molten potassium fluoborate follows two reaction stages: at temperatures up to 550 to 600° the first stage is expressed by $6KBF_4 + 3ZrO_2 \rightarrow 2BF_3 + 3K_2ZrF_6 + 2B_2O_3$, and the second at temperatures above 600° is described by the equation $3K_2ZrF_6 + 3KBF_4 \rightarrow 3K_3ZrF_7 + 3BF_3$, also, the overall reaction is: $9KBF_4 + 3ZrO_2 \rightarrow 5BF_3 + 3K_3ZrF_7 + 2B_2O_3$. Separation of BF_3 (second stage) takes place due to the thermal decomposition of KBF_4 liberating KF in the presence of K_2ZrF_6 which transforms into a more stable complex K_3ZrF_7. Introduction of potassium fluoride into the reaction mixture prevents BF_3 separation. (R.V.J.)

13787 SOLID SOLUTIONS IN CALCIUM ORTHOSILICATE–NEODYMIUM ORTHOSILICATE SYSTEMS. N. A. Toropov and N. F. Fedorov. Zh. Neorgan. Khim., 9: 156-63(Jan. 1964). (In Russian)

Crystal optical and x ray studies of calcium orthosilicate reactions with neodymium orthosilicate revealed a homogeneous region. The maximum solid solution concentration was at 40 wt% neodymium orthosilicate. A stabilizing effect produced by neodymium orthosilicate on a high temperature dicalcium silicate and formation of complex macroscopically homogeneous Ca_2SiO_4 crystals in a microheterogeneous diphase state were observed. (R.V.J.)

13788 THERMAL DISSOCIATION OF OSMIUM TETRACHLORIDE. N. I. Kolbin and I. N. Semenov. Zh. Neorgan. Khim., 9: 203-5(Jan. 1964). (In Russian)

The thermal dissociation of $OsCl_4$ was studied at 697 to 830°K. The dissociation pressure at 830° is over 5 atm. The equilibrium develops slowly at 697°K. Dissociation pressures for $OsCl_4$ are tabulated. The logarithm of the equilibrium pressure plotted against the reciprocal of the absolute temperature gives a straight line. (R.V.J.)

13789 SOLUBILITY OF LANTHANUM PHOSPHATES IN PHOSPHORIC ACID SOLUTIONS. I. V. Tananaev and

V. P. Vasil'eva (Kurnokov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 9: 213-14(Jan. 1964). (In Russian)

The solubility of $LaPO_4$ in H_3PO_4 solutions was studied at 25° with H_3PO_4 concentrations of 0.6 to 78%. The solubility of $LaPO_4$ increased with increasing concentration of H_3PO_4 and reached a maximum of 1.83%. The preparation of lanthanum acid phosphates was achieved with great difficulty. (R.V.J.)

13790 PREPARATION AND PROPERTIES OF POTASSIUM SILICOZIRCONATES. V. G. Chukhlantsev and K. V. Alyamovskaya (Urals Polytechnic Inst., USSR). Zh. Neorgan. Khim., 9: 216-18(Jan. 1964). (In Russian)

An analysis was made of the reaction of zirconium silicate with potassium hydroxide. It was shown that potassium silicozirconate, K_2ZrSiO_5, forms in a 25 to 82% solution of potassium hydroxide at 270 to 345°C. The preparation and physicochemical properties of K_2ZrSiO_5 are described. (R.V.J.)

13791 PREPARATION AND PROPERTIES OF BERYLLIUM ANTIMONIDE Be_3Sb_2. Ya. A. Ugai, V. L. Gordin, and V. Z. Anokhin (Voronezhskii State Univ., USSR). Zh. Neorgan. Khim., 9: 218-20(Jan. 1964). (In Russian)

The preparation of Be_3Sb_2 (beryllium antimonide) was developed in a specially designed high-stability vacuum installation using 99.8% pure beryllium powder and antimony with not more than 2×10^{-3}% admixtures. The preparation and properties of Be_3Sb_2 are described. (R.V.J.)

13792 MELTING DIAGRAMS FOR YCl_3–NaCl AND YCl_3–KCl SYSTEMS. B. G. Korshunov and D. V. Drobot (Moscow Inst. of Fine Chemical Tech.). Zh. Neorgan. Khim., 9: 222-3(Jan. 1964). (In Russian)

Phase diagrams were constructed for YCl_3–NaCl and YCl_3–KCl systems. The melting points of yttrium, sodium, and potassium were 700, 800, and 774°, respectively. A thermal analysis revealed a white chemical compound Na_3YCl_6 with a melting point of 550°. The Na_3YCl_6 formed a eutectic with yttrium chloride containing 45 mole % NaCl and melting at 360°. A thermal analysis of the YCl_3–KCl system revealed two chemical compounds: white colored KY_3Cl_{10} and K_3YCl_6 melting congruently at 535 and 830°, respectively. The eutectic formed by KY_3Cl_{10} and K_3YCl_6 contained 50 mole % KCl and melted at 430°, and the eutectic of K_3YCl_6 with KCl contained 87 mole % KCl and melted at 675°C. (R.V.J.)

13793 MASS SPECTRA OF VAPORS IN $ErCl_3$–KCl SYSTEM. G. A. Semenov and F. G. Gavryuchenkov. Zh. Neorgan. Khim., 9: 224-5(Jan. 1964). (In Russian)

Mass spectrometric analysis of the $ErCl_3$–KCl system showed considerable stability in the vapor at temperatures up to 1000°. The ionic species identified in the system are: K^+, KCl^+, Er^+, $ErCl^+$, $ErCl_2^+$, $KErCl_2^+$, and $KErCl_3^+$. (R.V.J.)

13794 NUCLEAR MAGNETIC RESONANCE IN HYDRATED CRYSTALS OF URANYL NITRATE. N. M. Aleksandrov, V. M. Vdovenko, A. P. Sokolov, and V. A. Shcherbakov (Leningrad State Univ.). Zh. Strukt. Khim., 4: 762-3(Sept.-Oct. 1963).

The application of nuclear magnetic resonance (NMR) as a supplement to the method of x-ray diffraction to determine the position of the protons of the water molecules in $UO_2(NO_3)_2 \cdot 6H_2O$, $UO_2(NO_3)_2 \cdot 3H_2O$, and $UO_2(NO_3)_2 \cdot 2H_2O$ is described. Polycrystalline samples of uranyl nitrate hexa-, tri-, and dihydrate were prepared and analyzed for uranium content by a gravimetric method. The contours of the NMR lines of H^1 were investigated at room temperature and at 177°K (samples of about 3 grams in weight were sealed into glass ampoules). The fine structure of the NMR lines is presented in a graph of the first derivative of the nuclear magnetic resonance line of the protons in hydrated uranyl nitrate crystals, and the values of the second moments of these spectra are presented. A comparison of the spectra showed low temperature has little influence on the shape and details of the line contour. ΔH^2 for the di- and trihydrate somewhat exceed the value of the second moment for the intramolecular fraction of ΔH^2 of the isolated water molecule, while ΔH^2 for the hexahydrate is substantially smaller. (OTS)

13795 CRYSTAL STRUCTURE OF SILICON RICH SILICIDES OF SCANDIUM AND YTTRIUM. E. I. Gladyshevskii and E. I. Emes-Misenko. Zh. Strukt. Khim., 4: 861-4(Nov.-Dec. 1963). (In Russian)

X-ray studies (phase analysis and calculations of line intensities) of Sc and Y systems with silicon (containing 50, 60, 62.5, and 66.7% Si) showed Sc_3Si_5 and Y_3Si_5 compounds with AlB_2 type structure. Lattice constants for Sc_3Si_5 were $a = 3.66 \pm 0.01$ and $c = 3.87 \pm 0.01$ Å, and for Y_3Si_5, $a = 3.842 \pm 0.002$ and $c = 4.140 \pm 0.002$ Å. (tr-auth)

13796 ON THE COMPOSITION AND STRUCTURE OF HAFNIUM CARBIDE. V. I. Zhelankin and V. S. Kutsev (All Union Research Inst. of Chemical Reagents and Pure Substances, USSR). Zh. Strukt. Khim., 4: 865-7(Nov.-Dec. 1963). (In Russian)

The composition and structure of homogeneous hafnium carbides were studied. Chemical and x-ray analyses were used for determining carbide homogeneity for $HfC_{0.58\ to\ 0.66}$ and $HfC_{0.99}$. The lattice period for a stoichiometric composition was 4.629 kX. The obtained data were correlated with data on solid solutions of Hf(Zr), C, O, and N containing 5% Zr. (R.V.J.)

13797 ELECTRONEGATIVITY AND BONDING OF TRANSITION METALS. R. B. Dobrotin. Zh. Strukt. Khim., 4: 881-4(Nov.-Dec. 1963). (In Russian)

A scale of transition metal electronegativity (Ti, Zr, Hf, V, Tb, Nb, Ta, Cr, Mo, W, and U) was constructed using the bond energy in halides and postulating an arithmetical mean. The metal-metal bond was evaluated at 40 kcal/mole. Electronegativity varied, regularly depending on Cl, Br, and I addends. (R.V.J.)

13798 ION RADII IN MOLECULES OF INORGANIC COMPOUNDS. K. S. Krasnov. Zh. Strukt. Khim., 4: 885-91(Nov.-Dec. 1963). (In Russian)

The semi-empirical system of ion radii in gaseous molecules of inorganic compounds was supplemented by radius values for lanthanide and actinide subgroups. The radii were calculated by semi-empirical and empirical methods. (R.V.J.)

13799 ELECTRON PARAMAGNETIC RESONANCE IN LIQUID SOLUTIONS CONTAINING Gd^{3+}. N. S. Garif'yanov and N. F. Usachev. Zh. Strukt. Khim., 4: 916-18(Nov.-Dec. 1963). (In Russian)

Electron paramagnetic resonance spectra in $Gd(NO_3)_3 \cdot 6H_2O$ liquid salt solutions were studied as a function of concentration, viscosity, and temperature. Measurements were carried out with a standard RE-1301 radioscope using 9320 Mc at 400 to 240°K. Water, methanol, ethanol, butanol, and glycerine were used as diluents. (R.V.J.)

13800 THERMIONIC PROPERTIES OF PRASEODYMIUM AND NEODYMIUM SULFIDES. V. I. Marchenko, G. V. Samsonov, and V. S. Fomenko (Kiev Inst. of Metal Ceram-

ics and Special Alloys). Zh. Tekhn. Fiz., 34: 128-30(Jan. 1964). (In Russian)

Thermoemission by Pr and Nd mono- and sesquisulfides was studied at 800 to 1500°C. Specimens of Pr_2S_3 and Nd_2S_3 were prepared by powder compression in H_2S at 1400°C. A table of Pr_2S_3 and Nd_2S_3 yields (φ_t) at various temperatures, current densities, and Richardson constants is presented. Comparisons of the emission properties of praseodymium and neodymium sulfides and of previously examined lanthanum sulfides confirm the concept of a metal-nonmetal donor-acceptor mechanism. (R.V.J.)

13801 THE PROPERTIES OF SALTS OF LOW SOLUBILITY OF PHOSPHOMOLYBDIC ACID AS CATION EXCHANGERS. J. K. Schroeder. Thesis, Karlsruhe, Ger., Technische Universität, 1963, 78p. $2.00(Gmelin, AED-DISS. 63-112). (In German)

The properties of synthetic inorganic substances as ion exchangers are discussed. Solubilities of the ammonium and rubidium salts of phosphomolybdic acid in HNO_3 were studied as a function of acid concentration using P^{32} and Rb^{86}. The exchange of carrier-free Cs^{137} and Y^{91} with ammonium molybdatophosphate was very rapid. More than 99.7% is exchanged in less than 1.5 sec. (Gmelin Inst.)

13802 LABELING OF HYDROCARBONS BY EXCHANGE. CONDITIONS FOR HIGH YIELD. B. E. Gordon and J. J. Madison (Shell Co., Emeryville, Calif.). 23p. (CONF-398-1)

From 7th Symposium on Advances in Tracer Methodology, Los Angeles, Mar. 1963.

Studies were made on the exchange between D_2O or D_2 and some hydrocarbons. Aluminum oxide and Co/Mo/S were evaluated as catalysts for the exchange and optimum conditions for yield and minimum decomposition were determined. The results show that D_2 is a more effective reagent for the exchange than D_2O. Higher yields and lower decomposition rates result. Yields above 50% equilibrium can be obtained with either D_2O or D_2 at 400°C and ~4 hr. With D_2 yields as high as 86% were observed in a few hours. N-alkanes and cyclanes exchange at similar rates, but isoalkanes (isopentant) exchange more rapidly. The mechanism of the exchange reactions is discussed. Data are tabulated. (P.C.H.)

13803 IMPROVEMENTS IN METHODS AND APPARATUS FOR THE PREPARATION OF GRANULAR URANIUM OXIDE. Maurice Delange, Henri Huet, and Paul Vertes (to Commissariat a l'Energie Atomique). British Patent 950,510. Feb. 26, 1964. Priority date May 18, 1960, France.

The preparation of granules from an aqueous paste of UO_2 or of ammonium uranate is described. The paste is broken into lumps and heated to dryness, and in the case of ammonium uranate the paste is then heated in the presence of an oxidizing gas to form UO_2. The apparatus for accomplishing the process is described. (R.E.U.)

13804 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF ALKALINE EARTH METALS. Allan Robert Gibson and Jan Zbigniew Lang (to United Kingdom Atomic Energy Authority). British Patent 950,889. Feb. 26, 1964. Filed Oct. 25, 1961.

A method and apparatus are described that are used in the production of calcium, strontium, and barium from their salts. The sulfide of the metal is dissolved in a fused salt bath and electrolyzed using a cathode of the rare earth metal alloyed with copper. This causes an upward flow of the enriched alloy to a vacuum distillation device where the metal is removed from the alloy. The depleted alloy is gravity-returned for further enrichment. (R.E.U.)

Organic Chemistry

13805 (ANL-6769(p.3-5)) FLUORESCENCE DECAY-TIME MEASUREMENTS. I. B. Berlman and O. J. Steingraber (Argonne National Lab., Ill.).

Measurements were made of the fluorescence decay time of several organic scintillators in the nanosecond range. The measuring apparatus was improved by replacing several component parts. Measurements were made on several deuteriated compounds and these were compared with similar, but hydrogen-containing, compounds. The apparatus was also modified to measure longer decay times. (M.C.G.)

13806 (EUR-582.d) WARMELEITFAHIGKEIT EINIGER POLYPHENYL UND POLYPHENYLMISCHUNGEN. (Thermal Conductivity of Some Polyphenyls and Mixtures Thereof). F. W. Reiter (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 32p.

The thermal conductivity of some organic liquids which are important as reactor coolants were determined in a stationary hot wire cell. The substances were diphenyl, o-, m-, p-terphenyl, Dowtherm A, and OM_2, a terphenyl mixture which shall be used in the Orgel-reactor. The measurements were made from the melting point up to about 50°C below the normal boiling point. The error is estimated to be less than 2%. (auth)

13807 (EUR-594.d) BESTIMMUNG DER ZAHIGKEIT VON POLYPHENYLEN MIT HILFE EINER METHODE FUR KLEINE SUBSTANZMENGEN. (Microdetermination of the Viscosity of Polyphenyls). G. Friz (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 44p.

A micro-method for measuring the viscosity of liquids in the temperature range from 20 to 450°C is described. Concerning diphenyl, o-, m-, p-terphenyl, and two technical mixtures experimental results are given. Theoretically the exploitation formula is substantiated and the limits and errors of the method are discussed. The overall error is estimated to be 1.5%. The viscosity range extends from 0.2 to 10 cp. The required volume of test substance is about 0.2 cm^3. (auth)

13808 (IS-592) THE CRYSTAL STRUCTURE OF BIS(META-CHLOROBENZOYL) METHANE. Gordon R. Engebretson and R. E. Rundle (Ames Lab., Ames, Iowa). Dec. 13, 1962. Contract W-7405-eng-82. 26p.

The crystal structure of bis(meta-chlorobenzoyl) methane was determined by three dimensional anisotropic least squares refinement of scintillation counter data. The molecule was found to be nearly planar with a maximum deviation from the least squares molecular plane of 0.068Å and an average deviation of 0.023Å. Fourier transform techniques to locate phenyl rings provided the key to the structure determination. The intramolecular bond distances and thermal parameters of the oxygen atoms support a resonant, enol ring with a symmetric, intermolecular hydrogen bond. The structure confirms conclusions from the structure of bis(meta-bromobenzoyl) methane where the symmetry of the molecule was forced by the crystal symmetry. (auth)

13809 (IS-631) MASS SPECTROMETRIC EVIDENCE FOR THE PYRIDOXAL-LEUCINE REACTION MECHANISM. G. A. Junk and H. J. Svec (Ames Lab., Ames, Iowa). Mar. 8, 1963. Contract W-7405-eng-82. 9p.

The mass spectrum of leucine-d_n, prepared by the reaction of pyridoxal with excess leucine in a D_2O medium, was established using the crucible source technique. From this

mass spectrum, the number and distribution of the deuterium atoms were calculated. Complete α, β exchange occurred and this is shown to be consistent with the proposed mechanism for the amino acid-pyridoxal system. The reaction can be used for the selective α, β-deuteration of amino acids other than leucine. (auth)

13810 (ORNL-3537(107-10)) ORGANIC PREPARATIONS. J. C. White, P. F. Thomason, and H. L. Holsopple (Oak Ridge National Lab., Tenn.).

A number of special organic compounds that are not commercially available were prepared on request from other research divisions. These compounds were ammonium pyrrolidinedithiocarbamate, 18 monoacid esters, tetra-n-butylammonium tetrabromonickelate(II), and benzyltributylphosphonium tetrachloronickelate(II). Tetrapentylammonium bromide, ethyl cyanide, and phenol were purified for use in special applications. (auth)

13811 (TID-18581) INFRARED SPECTRA OF CYCLIC PHOSPHONATE ESTERS. T. H. Siddall, III, and R. N. Wilhite (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Apr. 1963. Contract AT (07-2)-1. 13p.

A number of medium to strong bands was found in the infrared spectra of heterocyclic esters of 1,3 and 1,4 glycols with phosphonic acids. A set of such bands appears to be characteristic of the esters of a given glycol with all the phosphonic acids. Some of the bands of each set were also observed for esters of phenylphosphoric acid. Such sets of bands were not reported for other organophosphorus compounds. (auth)

13812 (TID-20249) DONOR PROPERTIES OF SOME SULFUR COMPOUNDS. Robert J. Niedzielski, Russell S. Drago, and Richard L. Middaugh (Illinois. Univ., Urbana. Noyes Lab. of Chemistry). [1963]. Contract AT(11-1)-758. 18p.

Evidence is presented to indicate that the compounds $CH_3C(S)N(CH_3)_2$, $(CH_3)_2NC(S)N(CH_3)_2$, and $C_6H_5SCH_3$ form sulfur coordinated adducts with iodine and phenol while $CH_3C(O)SCH_3$ forms oxygen coordinated adducts. The thermodynamic data for formation of these adducts in CCl_4 solution are reported and the donor properties are interpreted in terms of the electronic structure of the donor and the nature of the donor-acceptor interaction. These interpretations are substantiated by the C^{13}-proton NMR coupling constants. Evidence is presented to indicate substantial C–S pi-bonding in CH_3COSCH_3. (auth)

13813 ORGANIC MATERIALS USED AS MODERATORS AND COOLING AGENTS OF NUCLEAR REACTORS. P. T. Frangopol. Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 437-51(1963). (In Rumanian)

The increased use of organic moderators and coolants promises to help to reduce substantially the cost of electrical energy generated by nuclear power stations. The organic liquids used must have a low atomic mass, a low neutron capture cross section, and should not contain elements which can be activated. The activity induced in the liquid is due to the dissolved structural materials, mineral impurities, and the C^{13} and C^{14} produced by the radiation. A large portion of this activity may be eliminated by filtering off the solids and by purifying the polymer formed. The liquids should also possess a high boiling point, near 400°C, low melting point and viscosity, while being noncorrosive and resistant to heat and radiation. A high heat-transfer coefficient is also necessary for efficient operation. Aromatic hydrocarbons were found to be superior to unsaturated, aliphatic ones. The properties of monoisopropyl biphenyl, monomethyl biphenyl, biphenyl, and terphenyl are reviewed. The liquids tested revealed compatibility with sintered U and lack of reaction with water. The disadvantages of these materials include their high melting point, relatively low heat transfer coefficient (6 times lower than that of water), and tendency toward radiolysis and pyrolysis, resulting in polymerization. The experience with a number of organic-cooled and/or moderated reactors, such as the OMRE, Piqua, OCDMR, OTR, ORGEL and Essor is analyzed. (Review article, 55 references) (TTT)

13814 FURTHER INVESTIGATIONS WITH DEUTERATED CONIFERYL ALCOHOL. Karl Freudenberg and Vladan Jovanovic (Universität, Heidelberg). Chem. Ber., 96: 2178-81(1963). (In German)

Synthesis of deuterated vanillin derivatives and their conversion to the corresponding coniferyl alcohols are described. Treatment of 10 g 6-bromovanillin dimethyl acetal in 170 ml ether at –50°C with 2.1 equivalents ethereal butyllithium added dropwise, maintaining the reaction at 0° 15 min, decomposing it with 6 ml 98% D_2O, refluxing 90 min, diluting with 150 ml water, saturating with CO_2 or slightly acidifying with HCl, extracting with ether that is then evaporated, warming the residue with 0.5N HCl, extracting with ether, drying the extract, and replacing ether evaporatively with cyclohexane yields 6-deuterovanillin from cyclohexane (3.2 g, 76%, mp 79.5–80°, 0.95 D/mole). By a similar procedure 2-deuterovanillin is prepared from 2-bromovanillin dimethyl acetal. These were converted into the corresponding coniferyl alcohols by known procedures and thence enzymatically into artificial lignin. The 6-deuterated unit lost 8% D in the enzymatic process and the 2-deuterated unit 4%, corresponding to the approximate ratio of metahemipinic and hemipinic acids found as degradation products. The conversion of coniferyl alcohol to lignin is discussed in light of this. (BBB)

13815 LABELING OF AROMATIC HYDROCARBONS BY TRITIUM ATOMS PRODUCED IN THE REACTION $Li^6(n,\alpha)H^3$. Elena Ciranni, Giovanna Ciranni, and Angelo Guarino (Università, Rome). Gazz. Chim. Ital., 93: 610-17(June 1963). (In Italian)

Very pure samples of toluene, ethylbenzene, and cumene were degassed and sealed in quartz ampoules with dried lithium carbonate. These were irradiated for 90 minutes in the Avogadro nuclear reactor of the Società Sorin at Saluggia (normal integrated flow 3.7×10^{16} neutrons/cm^2), and the products were separated by gas chromatography. Gases incondensable at –196°C (HT and CH_3T) were separated on a molecular sieve. Crude condensable products were analyzed; these were purified by distillation through a fractionating column equivalent to 35 theoretical plates, and analyzed once again. Finally the samples were purified by preparative vapor-phase chromatography and their radioactivity analyzed a third time. All the hydrocarbons examined incorporated about 15% of the tritium produced in the nuclear reaction; this figure was independent of the amount of lithium carbonate used. One sample of ethylbenzene irradiated for an extended period had a specific activity of 434.8 mC/mg when crude; after purification to constant activity by the first method it had 238 mC/mg; after second method, 212.5 mC/mg. Dependence of activity on purity renders earlier work of other investigators questionable. In toluene irradiation, 15% of the T is in toluene, 15% in toluene-soluble compounds, 5% at the most in gases (HT, CH_3T); other hydrocarbons gave similar distributions. The ratio of CH_3T:HT increases in the order

toluene < ethylbenzene < cumene. Tritiated benzene is formed in yields of 4% from toluene and ethylbenzene, and 2% from cumene. Tritiated acetylene, ethylene, ethane, propane, and isobutane were also detected and their yields determined. Modes of formation of some of these labeled hydrocarbons are discussed briefly. (BBB)

13816 STERIC ISOTOPE EFFECTS. THE ISOTOPE EFFECT ON THE RACEMIZATION OF 2,2'-DIBROMO-4,4'-DICARBOXY-BIPHENYL. Lars Melander and Robert E. Carter (Mobel Inst. of Chemistry, Stockholm). J. Am. Chem. Soc., 86: 295-6(Jan. 20, 1964).

Optically active 2,2'-dibromo-4,4'-dicarboxybiphenyl specifically deuterated in the 6 and 6' positions was prepared for the appraisal of the importance of steric factors in secondary deuterium isotope effects that allows a comparison between theory and experiment. Results obtained at -19.8 ± 0.1°C in ethanol solution are reported. The isotope effect ratio (k_D/k_H) was calculated as 1.19. Data on racemization rates are tabulated. (P.C.H.)

13817 THE CONFORMATIONAL DEPENDENCE OF SECONDARY DEUTERIUM ISOTOPE EFFECTS IN SOLVOLYTIC REACTIONS. V. J. Shiner, Jr., and John G. Jewett (Indiana Univ., Bloomington). J. Am. Chem. Soc., 86: 945-6(Mar. 5, 1964).

A comparison was made between deuterium isotope effects on the rate of solvolysis of cis-4-t-butylcyclohexyl brosylate-trans-2-d (single axial β-deuterium) and cis-4-t-butylcyclohexyl brosylate-cis-2-d (single equatorial β-deuterium). The results showed that axial β-deuterium slows the solvolysis rate by a factor of 1.436, which is the largest reported secondary isotope rate effect attributable to a single β-deuterium atom. On the other hand, the equatorial β-deuterium atom slows the solvolysis rate by the dramatically reduced factor of 1.096. Thus, the conformational dependence of the β-deuterium effect, predicted by the hyperconjugation postulate, was confirmed. (P.C.H.)

13818 EXCITATION ENERGY TRANSFER FROM TOLUENE TO SOME ORGANIC SCINTILLATORS. W. H. Melhuish (Univ. of California, Los Angeles). J. Chem. Phys., 40: 1369-73(Mar. 1, 1964).

A general equation is derived from the light output of a liquid scintillator as a function of solute concentration, which includes both radiative and nonradiative excitation energy transfer. The rate constants for energy transfer from toluene to 2,5-diphenyloxazole, anthracene, 9,10-diphenylanthracene, perylene, and methyl anthranilate, were determined from the equation using oxygen-quenching data obtained by γ-ray and uv excitation. The correction of the observed scintillation intensities for reabsorption and reemission of solute fluorescence is described. The corrected points were found to agree well with the general equation using transfer rate constants derived from oxygen-quenching studies. (auth)

13819 INVESTIGATION OF THE LOW-FREQUENCY MOTIONS IN ISOTACTIC AND ATACTIC POLYPROPYLENE BY NEUTRON INELASTIC SCATTERING. G. H. Safford (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.), H. R. Danner, H. Boutin, and M. Berger. J. Chem. Phys., 40: 1426-32(Mar. 1, 1964).

The vibrational spectra between 1000 and 30 cm^{-1}, derived from measurements of the inelastic scattering of cold neutrons, are presented for isotactic polypropylene at sample temperatures below and above both the glass transition and the melting point. A tentative assignment of the observed modes is suggested. In addition to the skeletal optical modes, the neutron spectra for isotactic polypropylene indicate the existence of two acoustic modes—skeletal deformation and skeletal torsion—with high-frequency limits at 620 ± 50 and 110 ± 10 cm^{-1}, respectively. As in polyethylene, the modes appear to be strongly influenced by the presence and phase of the disorder in the sample. Similar spectra for atactic polypropylene above and below the glass transition show a much less pronounced structure, although weak bands are observed which correlate well with the skeletal optical modes observed in the isotactic polymer. (P.C.H.)

13820 THE SYNTHESIS OF 4',5'-DIIODO-4-AMINOFLUORESCEIN IODINE-131. Anthony J. Verbiscar (Argonne Cancer Research Hospital, Chicago). J. Org. Chem., 29: 490-2(Feb. 1964).

Unlabeled 4',5'-diiodo-4-aminofluorescein was obtained by treating a solution of 4-aminofluorescein in 1N HCl with two equivalents of iodine monochloride. Exchange reactions of NaI^{131} with 4',5'-diiodo-4-aminofluorescein were accomplished in high radioactive yield by mixing the materials in acetic acid overnight. Warming was necessary to effect solution. (P.C.H.)

13821 DETERMINATION OF SMALL AMOUNTS OF CARBON-14 IN THE PRESENCE OF LARGE IODINE-131 ACTIVITIES, AND AN EXPERIMENTAL ESTIMATION OF THE SPECIFIC ACTIVITIES OF (^{131}I)-IODOTYROSINES. W. S. Reith and B. L. Brown (Inst. of Nuclear Medicine, Middlesex Hospital Medical School, London). Nature, 201: 621-2(Feb. 8, 1964).

The use of C^{14}-tyrosine in the iodination of high-specific-activity thyroid hormones, I^{131}-iodotyrosines, for tracer uses is described. Combustion testing and counting of the solution are reported. (R.E.U.)

13822 THE SELECTIVITY OF CATALYSTS IN THE HYDROGEN EXCHANGE REACTION OF p-XYLENE WITH DEUTERIUM OXIDE. Tomiko Ueda and Kozo Hirota (Osaka Univ.). Nippon Kagaku Zasshi, 84: 882-6(Nov. 1963). (In Japanese)

The isotopic exchange reaction of p-xylene with deuterium oxide was studied using rhodium, silver, and nickel-alumina as catalysts at 100°C, and the results were compared with those of previous studies. The reaction products were analyzed by infrared and mass-spectrometric methods. On rhodium catalyst, the exchange occurred at both hydrogen atoms of methyl groups and benzene ring of p-xylene, but on silver the exchange did not take place under the same experimental condition. The following order of the selectivity for benzene ring was found to exist among the metals studied: Pt > Pd > Rh > Ni, a new relation between the selectivity and the geometric factor of catalysts. When the surface of nickel-alumina had been previously exposed to diethylsulfide at room temperature, the exchange at methyl groups was more retarded than at the benzene ring. Furthermore, selectivity for the demethylation of p-xylene, low as it was, was confirmed only in the case of nickel-alumina under similar experimental conditions. The results suggest that the mechanism of the exchange of benzene ring is not the same for the cases of palladium and nickel-alumina catalysts. (auth)

13823 THE Sr-90 LEVEL IN URINE OF POPULATION IN POLAND IN 1962. Wanda Czosnowska (Inst. of Occupational Medicine, Lodz, Poland). Nukleonika, 8: 779-82 (1963).

The Sr^{90} to calcium ratio was determined in 11 pooled samples of urine collected from 620 persons professionally

non-exposed to the hazard of the incorporation of radionuclides. Small range of values around the mean (standard deviation of ab. ± 5% of the mean) as well as regular season-of-year dependent changes in concentration of Sr^{90} when expressed per gram of Ca suggest the existence of the definite Sr-90/Ca Observed Ratio between urine and diet in humans. (auth)

13824 THE STRUCTURE OF DIOXODI-8-QUINOLINOLATO-8-QUINOLINOLURANIUM(VI)-CHLOROFORM. D. Hall, A. D. Rae, and T. N. Waters (Univ. of Auckland, New Zealand). Proc. Chem. Soc., 21(Jan. 1964).

Studies were made on the structure of the uranyl complex with the composition $UO_2(C_{10}H_8NO)_2, C_{10}H_8N \cdot OH$. All three 8-quinolinol molecules are co-ordinated to the uranium atom, but they are not equivalent. They are very nearly coplanar and perpendicular to the linear uranyl ion, and all three phenolic oxygen atoms are co-ordinated, but only in two ligand molecules is the nitrogen also bonded to the uranium. The third 8-quinolinol molecule is twisted away from the uranium such that the two bonds involving the co-ordinated oxygen are almost collinear. The nitrogen atom is 4.1 Å from the uranium, but makes an approach of 2.79 Å to the phenolic oxygen of the adjacent ligand molecule. It is suggested that this singly co-ordinated ligand exists as a zwitterion. The crystals are monoclinic with a = 20.76, b = 8.75, c = 15.62 Å, β = 97.9°, 4 molecules per unit cell, space group $P2_1/n$. (P.C.H.)

13825 NEODYMIUM OXYBENZOATE. V. I. Ermolenko. Zh. Neorgan. Khim., 9: 48-55(Jan. 1964). (In Russian)

Studies of the electric conductivity and the amount of precipitate formed in the reaction of neodymium chloride with sodium salicylate indicated the formation of $NdSal_3 \cdot H_2O$ (neodymium salicylate) and $Nd(C_7H_5O_3)_3$ (neodymium hydroxybenzoate). The dissociation constants of neodymium salicylate, $K_1 = 1.4 \times 10^{-3}$, $K_2 = 4.2 \times 10^{-3}$, $K_3 = 1.3 \times 10^{-2}$, and $K = 7.4 \times 10^{-8}$, were calculated at 25° and 3×10^{-3} ionic strength. The solubility of neodymium salicylate in water and in sodium salicylate at 25° and the thermal stability of neodymium and sodium salicylates were investigated. Basic neodymium salicylates, $Nd(OH)Sal_2$ and $Nd(OH)_2Sal$, were separated and their higher stability is compared to that of the basic neodymium p-hydroxybenzoate. (R.V.J.)

13826 SYNTHESIS OF Zr AND Hf PHTHALOCYANINES. V. E. Plyushchev, L. P. Shklover, and I. A. Rozdin. Zh. Neorgan. Khim., 9: 125-7(Jan. 1964). (In Russian)

Reactions of phthalonitrile with zirconium and hafnium tetrachlorides resulted in the formation of stable zirconium and hafnium phthalocyanines, $C_{32}H_{15}N_8Cl \cdot Me(OH)_2 \cdot 2H_2O$. Absorption spectra of zirconium and hafnium phthalocyanines in α-bromonaphthalene were measured at 400 to 700 mμ. The maximum absorption bands were found at 693 and 691 mμ. (R.V.J.)

13827 COMPLEXING OF RARE EARTH IONS WITH 1,2-DIHYDROXYBENZENE-3,5-DISULFONIC ACID (TIRON). K. V. Tserkasevich and N. S. Poluektov (Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 9: 128-33(Jan. 1964). (In Russian)

Spectrophotometric studies of reactions between neodymium, holmium, and erbium salts with 1,2-dihydroxybenzene-3,5-disulfonic acid (Tiron) revealed two complex compounds. At pH7 the ratio between the metal and the Tiron in the complex is 1:1.5; at pH14 the ratio is 1:4. Additions of alcohol synthesized two neodymium complexes; the hexasodium salt of the dineodymium complex with tripyrocatecholdisulfonic acid and the monosodium salt of the neodymium complex of the pyrocatecholdisulfonic acid. (R.V.J.)

Radiation Chemistry and Radiochemistry

13828 (AERE-M-1284) THE RADIATION DECOMPOSITION OF SOME PHENYL-SUBSTITUTED ORGANOPHOSPHORUS(V) EXTRACTANT SYSTEMS. E. S. Lane and A. Pilbeam (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1964. 12p.

Some phenyl substituted organo-phosphorus extractants were irradiated in contact with dilute aqueous nitric acid. The resulting decomposition products, which are thought to contain phenolic groups ortho to the phosphoryl oxygen, were found to be powerful complexing agents for metals, and these extractants are thus unsuitable for use in nuclear reprocessing plants. The preparation of some di-phenyl substituted phosphine oxides by the Willans procedure, which avoids the use of Grignard Reagents, is described. (auth)

13829 (AERE-R-4505) A REVIEW OF THE HEAVY PARTICLE RADIOLYSIS OF SOLIDS. D. A. Dominey (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1964. 37p.

The review is mainly concerned with the chemical effects of heavy particle irradiation on ionic solids and includes discussions of the spontaneous decomposition of the compounds of heavy radioactive elements and the chemical effects of nuclear transformations such as Szilard-Chalmers reactions. The chemical changes which occur as a result of the formation of thermal spikes and the subsequent annealing of these changes are discussed. (auth)

13830 (AFOSR-4647) A SEARCH FOR HOST-SENSITIZED LUMINESCENCE OF RARE EARTH IONS IN $Sr_2ZrP_2O_9$. Scientific Paper 62-944-116-P8. N. T. Melamed and D. E. Harrison (Westinghouse Electric Corp. Research Labs., Pittsburgh). Dec. 28, 1962. 11p. (AD-406473)

The compound $Sr_2ZrP_2O_9$ belongs to a family of host luminescent materials whose properties appeared to be favorable for the production of host-sensitized luminescence. However, measurements which were performed on this compound activated by rare earths indicated that little or no sensitization was taking place. An estimate of the expected sensitized luminescence yields indicates that the failure to obtain sensitization can be accounted for by the low oscillator strengths of the rare earth ions. It suggests that rare earth ions are in general not well suited as activators in host sensitized systems except at comparatively high concentrations. (auth)

13831 (ANL-6769(p.55-8)) SCINTILLATIONS IN ARGON AND NITROGEN. Harvey A. Schultz (Argonne National Lab., Ill.).

Observations made on scintillations in argon and nitrogen, alone and in mixtures, excited by alpha particles, are discussed. The greatest pulse heights were obtained with argon alone. In mixtures, a pulse height minimum was obtained near 1% N_2 concentration and a maximum near 10%. There was a decrease of pulse height with increasing pressure above 4 atm. (M.C.G.)

13832 (CONF-117-40) RADIATION CHEMISTRY OF THYMINE IN AQUEOUS ALKALINE SOLUTION. L. S. My-

ers, Jr., W. T. Tsukamoto, J. F. Ward, J. R. Julca, and D. E. Holmes (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). [nd]. Contract AT-04-1-GEN-12. 15p.

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

Gamma radiolysis of thymine solutions was investigated over a wide pH range using ultraviolet absorption spectra and two-dimensional paper chromatography combined with radioautography. The results show that as the pH is increased, the spectrum change for a given dose decreases, $G(H_2O_2)$ increases, and G(organic peroxides) decreases. Several compounds were isolated from irradiated neutral or acidic solutions of thymine, while in strongly alkaline solutions, only hydroxymethyl uracil was found in appreciable amounts. It is concluded that radiolysis of un-ionized thymine (in acidic solution) proceeds by addition to the double bond, while in ionized thymine (in alkaline solution), the methyl hydrogens are more reactive. (D.L.C.)

13833 (CONF-403-1) ELECTRON SPIN RESONANCE OF AN IRRADIATED SINGLE CRYSTAL OF POTASSIUM HYDROGEN MALEATE. Machio Iwasaki and Koichi Itoh (Tokyo Univ. Inst. for Solid State Physics). Sept. 1963. 20p.

From Chemical Society of Japan 16th Annual Meeting, Tokyo, Apr. 1963.

Electron spin resonance absorptions of x-irradiated single crystals of potassium hydrogen maleate and potassium deuterium maleate were observed mainly at 24 kMc/sec as well as at 9 kMc/sec. Both compounds gave the same hyperfine structures, although the slightly sharper line widths were observed for the deuterium exchanged compound. The hyperfine structures were reasonably assigned to the two proton system. The direction of the minimum element of the coupling tensor approximately coincides with that of the C–H bond. The two coupling protons should be $\overset{H}{>}C=C\overset{H}{<}$. The line widths for both the compounds were very sharp and from one to two gauss in distance between maximum slopes. The largest difference between the line widths of the two compounds was only 0.5 gauss. This is very much smaller than the smallest possible difference expected for the case that the OH proton exists in the produced radical. The sharp line widths and their small change by the deuterium substitution suggest that the most probable radical is the one which is produced by the removal of the OH hydrogen atom. Since the direction of the minimum element of the g-tensor is perpendicular to the molecular plane, the unpaired electron is a π-electron in accordance with the prediction from the simple LCAO calculation. (auth)

13834 (EUR-477.e) HIGH PRECISION 4 $\pi\beta$-γ-COINCIDENCE COUNTING AND THE PREPARATION OF SOLID Co^{60} STANDARD SOURCES AND SOLUTIONS FOR AN INTERNATIONAL COMPARISON. A. Spernol, E. De Roost, and O. Lerch (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy and European Atomic Energy Community. Central Nuclear Measurements Bureau, Geel, Belgium). 1964. 29p.

The preparation and properties of electrolytically deposited Co^{60} sources and Co^{60} standard solutions are described. In addition, the $4\pi\beta$-γ-coincidence method used for the determination of their activities is discussed in detail with particular reference to the corrections which have to be applied to the measured results and their control. (auth)

13835 (HW-78948) RADIATION-INDUCED GAS–GRAPHITE REACTIONS IN SEALED CAPSULES. PART II. HYDROGEN, METHANE, CARBON MONOXIDE AND NITROGEN. B. A. Ryan (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 20, 1964. Contract AT(45-1)-1350. 28p.

Irradiations of several gases at various pressures in sealed quartz capsules, some containing graphite, were conducted either in a Hanford reactor at about 550°C or in a Co^{60} facility at about 30°C. Changes in gas composition and graphite weight were measured, and the nature of the deposited material was investigated. There was no measurable formation of CH_4 in capsules containing graphite and H_2 in the pressure range from 3 to 30 atm. However, the results of these experiments were not quantitative because of the loss of H_2 from the permeable quartz capsules. The radiation-induced decomposition of CH_4 to form H_2 and carbon was measured in capsules filled with H_2–CH_4 mixtures. In some of the capsules with this mixture, trace amounts of C_2H_6 and C_3H_8 were formed. Gamma irradiations of H_2–CH_4 mixtures to a total dose of 9.68×10^8 r produced very small changes in the gas composition. In capsules containing H_2–CO mixtures at total pressures ranging from 1 to 25 atm, the yield (~40 per cent) of CH_4 and CO_2 was good for the high exposure in these experiments. In only one of the four capsules filled with N_2 was any C_2N_2 detected in the gas phase; however, small amounts of a solid, believed to be paracyanogen, were found on the walls of the four capsules. (auth)

13836 (NYO-10025) THE EFFECT OF ELECTROPHILIC ADDITIVES ON THE RADIOLYTIC PRODUCTS OF ORGANIC CHAIN REACTIONS. Final Report. Philip L. Levins, El-Ahmadi I. Heiba, and Donna D. McRitchie (Little (Arthur D.) Inc., Cambridge, Mass.). Dec. 31, 1963. Contract AT(30-1)-2904. 60p.

The reactions induced by high energy radiation of isobutane–propylene mixtures, isobutane, and olefins adsorbed on silica gel and silica gel modified with electrophilic additives were studied. The effects of such variables as electron percent coverage, variation in metal oxide, method of incorporating and concentration of ferric oxide, mole ratio of reactants, and choice of olefin were determined. Extensive energy transfer from the support to the adsorbed hydrocarbon was demonstrated for each hydrocarbon studied. Enhanced yields were observed for the propylene alkylation of isobutane on modified silica gels compared with that obtained on silica gel. The alkylation was shown to proceed preferentially by an ionic reaction mechanism. Factors considered important for interpretation of the results include surface chemisorption of the olefin and semiconductor properties of the support. The possibility of utilizing high energy radiation to promote ionic chain reactions with an efficient use of the radiation energy was demonstrated. These results are in distinct contrast with the usual free radical reactions observed in radiation studies of hydrocarbons. (auth)

13837 (ORNL-3537(p.58-60)) EFFECTS OF RADIATION ON ANALYTICAL METHODS. J. C. White and P. F. Thomason (Oak Ridge National Lab., Tenn.).

Dimethylglyoxime was found to be much less resistant to gamma radiation than is its complex with nickel. The radiation damage to 1×10^{-5} M solutions of dimethylglyoxime was of the order of 1×10^{-10} millimole ml^{-1} rad^{-1}. A postirradiation effect was noted when ethyl alcohol was used as the solvent but not with aqueous solutions. The radiation damage to arsenazo III solutions (in the form of its disodium salt) was determined. In strong acid (9 N) the average rate of decomposition was of the order of 2×10^{-6} mole/liter per kilorad of gamma radiation. The damage was less in more dilute acid solutions. Decomposition con-

tinued as a postirradiation effect. Investigations of the effect of gamma radiation on spectrophotometric thiocyanate methods for molybdenum, iron, and uranium were completed. The molybdenum complex was essentially destroyed by radiation doses greater than 1×10^4 rads. The same dose resulted in an 8 to 22% error for the iron complex. Uranium thiocyanate was affected even less, of the order of 10%. (auth)

13838 (RRL-111) RADIOLYSIS OF ETHYL IODIDE IN THE LIQUID PHASE. Ralph N. Schindler (Mellon Inst. Radiation Research Labs., Pittsburgh). Apr. 19, 1963. Contract AT(30-1)-2310. 19p.

The Co^{60}-γ-radiolysis of ethyl iodide with and without additives (up to 4.5 moles/l I_2) was investigated in the approximate range of 10^{-3} to 1% decomposition. Ethane formation in pure irradiated ethyl iodide occurs to only 50% by reactions under steady state conditions. The residual ethane results from diffusion controlled reactions in spurs. "Hot" processes are found to be of minor importance. Ethylene and butane production occurs in the tracks exclusively. The upper limit for ethylene formation via unimolecular elimination is estimated to $G < 0.6$. (auth)

13839 (TID-20201) RESEARCH IN NUCLEAR AND RADIOCHEMISTRY. Annual Progress Report for Year Ending January 31, 1964. T. T. Sugihara (Clark Univ., Worcester, Mass.). Contract AT(30-1)-1930. 58p.

High-energy reaction results are presented for the isomeric ratios of Te^{127} and Te^{129} as formed in (p,pn) reactions and in neutron-transfer reactions with C^{12} and N^{14}. The fission recoil ranges of fragments in 150-Mev proton fission of U^{238}, as determined in recent years, are discussed briefly. Continued search for the mass region in which fission in the liquid-drop sense should vanish is reported. A model is proposed to explain reactions which are characterized by neither single-particle excitation nor compound-nucleus formation but rather by some intermediate form of excitation. In compound-nuclear reaction studies, isomeric cross-section ratios of Ce^{137}, formed by the reactions $La^{139}(p,3n)$, $Ba^{136}(\alpha,3n)$, and $Te^{128}(C^{12},3n)$, are reported. A theoretical treatment for isomeric ratios in α-particle-induced reactions is presented in which the effect of competing evaporation paths is explicitly taken into account. The moments of inertia deduced are invariably less than the rigid-body value. A revised model is proposed in which the level density is taken to be zero for spins above a certain maximum value which is determined by a Fermi gas model. (auth)

13840 (TID-20203) STUDIES OF THE RADIATION CHEMISTRY OF ORGANIC COMPOUNDS. Progress Report, January 16, 1963–January 31, 1964. Norman N. Lichtin (Boston Univ.). Contract AT(30-1)-2383. 18p.

Results obtained by Co^{60} gamma radiolysis of oxygenated methanol are presented along with those obtained by subjecting methanol to $B^{10}(n,\alpha)Li^7$ recoils. Yields were determined chromatographically and by colorimetric methods. The effects of water on the peroxide yields in Co^{60} gamma radiolysis of aerated methanol were investigated. Data on reactions of N_2 with C^{14}-labeled organic molecules are included. (J.R.D.)

13841 (TID-20295) THE EFFECTS OF RADIATION ON CHEMICAL SYSTEMS. Progress Report, January 1, 1963–December 31, 1963. Alexander R. Amell (New Hampshire. Univ., Durham). Contract AT(30-1)-1911. 23p.

A summary of the results of the work on three problems are given. These are: the radiation chemistry ammonia and the methylamine–ethane system; the radiation chemistry of aqueous and alcoholic solutions of methyl orange and orange IV; and the radiation chemistry of acidic solutions of stannous ion. (auth)

13842 (TID-20296) RADIATION DAMAGE STUDIES IN SOLIDS USING THE TECHNIQUES OF ELECTRON-SPIN PARAMAGNETIC RESONANCE AND NUCLEAR MAGNETIC RESONANCE. Annual Progress Report, May 1, 1963–April 30, 1964. P. J. Bray and H. O. Hooper (Brown Univ., Providence). Mar. 1, 1964. Contract AT(30-1)-2024. 64p.

The series of potassium halides, KF, KCl, KBr, and KI were studied in order to compare the behavior of these compounds when they are subjected to a wide variety of neutron irradiation conditions. Extensive NMR (nuclear magnetic resonance) studies of KBr were carried out since the bromine nuclei serve as sensitive probes detecting changes in the electrical environment of bromine atoms through nuclear electric quadrupole interactions. ESR (electron spin resonance) measurements were also made on these materials, and the results were combined with the NMR results to estimate the rate of atomic displacement during neutron irradiation, the F-center production rate, and the thermal behavior of the defect centers introduced by neutron irradiation. The results indicated that the mean free path of displaced ions, although somewhat temperature dependent, is quite long in these crystals. In addition, the vacancy system induced by the irradiation is apparently produced in clusters. The association of these vacancies to form more complicated defects was found to be influenced rather strongly by the ambient irradiation temperature. NMR studies of lithium fluoride and lithium bromide were completed. Studies of neutron-irradiated LiF were centered about a careful investigation of the F^{19} NMR line from F_2 gas produced by irradiation. The chemical shift of this species was accurately determined, and the amount of F_2 gas produced at several total neutron doses was determined. Results from the NMR study of LiBr were inconsistent as far as a determination of the numbers and types of defects produced in this material by neutron irradiation. Such inconsistences can readily be attributed to variations in temperature and neutron flux for the various samples, all of which were irradiated for different time intervals in the same reactor facility. An NMR study of neutron irradiation effects in NaI single crystals was initiated and extensive pre-irradiation data obtained. Studies of irradiated borate glasses by ESR techniques were extended to glasses of high alkali oxide concentration and to crystalline compounds that exist in the phase-equilibrium diagrams of these alkali–borate systems. From the ESR results an estimate of the approximate value for the density of the boron 2s electron at the site of the boron nucleus was made. The four- and five-line hyperfine structures observed in these borate glasses were examined in detail experimentally in the alkali borate and in the CABRAL glass systems, and the defect centers responsible for these hyperfine structures were identified. The ESR spectra from several alkali borate compounds were compared with the spectra obtained from glasses of similar compositions in order to determine if the same structural units, which were identified by x-ray techniques in the compounds, exist in the glasses. ESR studies of iron group ions in glasses and associated crystalline compounds were initiated. Glasses were doped with Fe^{3+}, Mn^{2+}, Co^{2+}, Cr^{3+}, and Ni^{2+} ions in an attempt to gain information on the glass structure. In most cases examined to date, additional work will be required in order to determine the exact nature of the site or sites which are responsible for the observed ERS spectra. (auth)

13843 (AEC-tr-6314) PRINCIPLES OF RADIOCHEMISTRY. I. E. Starik. Translation of "Osnovy Radiokhimii," (a publication of the Publishing House of the Academy of Sciences, USSR, Moscow-Leningrad, 1959). 519p.

This book is a systematic exposition of the theoretical basis and principal problems of radiochemistry. Its four chapters are entitled: The State of Microquantities of Radioactive Isotopes in Liquid, Gaseous, and Solid Phases; Distribution of Microquantities of Radioactive Isotopes in Heterogeneous Systems; Adsorption of Radioactive Isotopes; and Electrochemistry of Radioactive Substances. (D.L.C.)

13844 CONTRIBUTION TO THE STUDY, BY MEANS OF ELECTRON PARAMAGNETIC RESONANCE, OF GLYCOCOLL IRRADIATED IN A REACTOR. I. Pascaru, M. Constantinescu, and O. Constantinescu (Institutul de Fizica Atomica, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 393-8(1963). (In Rumanian)

The electron paramagnetic resonance spectra of polycrystalline glycocoll irradiated in a reactor were studied. Each spectrum has 7 lines whose relative intensity varies with the dose and heating. They are interpreted by the superposition of the spectra of two radicals: NH_2^+ that gives a triplet and $^+NH_3 - \dot{C}H_2$ that gives a sextet. The variation with time of the number of radicals at 60 and 100°C was studied, and the lifetime of the two species of radicals was determined for 60°C. (tr-auth)

13845 INFLUENCE OF RADIATION ON THE NUCLEAR MAGNETIC RESONANCE OF SODIUM-23 IN SODIUM CHLORIDE. M. Weiner and M. Rotaru (Institutul de Fizica Atomica, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 529-34(1963). (In Rumanian)

The resonance of Na^{23} in natural and synthetic NaCl single crystals exposed to γ radiation of Co^{60} at room temperature for 20 days while in contact with the 20-curie source, a 2×10^{18} nt/cm^2 flux at the temperature of the beamhole or 200 to 300°C with specimens kept for about 5 months after the irradiation, and a 1×10^{18} n/cm^2 at 50°C (with specimens kept for 1 month after the irradiation). A nuclear magnetic resonance spectrometer was used for the determinations; it was operated at 5 million cps at a magnetic field strength of $H_0 = 4435$ oersted. The natural and synthetic single crystals yielded identical spectra. Irradiation, especially by neutrons at room temperature affected the shape of the curves. The slighter effect at elevated temperature was probably due to the lower thermal neutron cross section, the temperature difference during irradiation, and to recombination prior to the measurements. The γ radiation and the low-temperature neutron radiation reduced the relaxation length. An attempt was made, unsuccessfully, to interpret the data obtained on the basis of Bloch's equations; the lack of agreement might be due to the fact that in the single crystals examined the absorption line is inhomogeneously magnified, limiting the applicability of the phenomenological theory. (TTT)

13846 SYNTHESIS OF ^{32}P-LABELED DIMETHYLAMIDO ETHOXYPHOSPHORYL CYANIDE (TABUN). E. Heilbronn and L. Fagerlind (Research Inst. of National Defence, Sundbyberg, Sweden). Acta Chem. Scand., 17: 2688-90(1963).

P^{32}-labeled Tabun was synthesized from phosphoryl trichloride and carrier-free P^{32}-labeled orthophosphoric acid. A chromatographic method for the purification of dimethylamido phosphoryl dichloride and of Tabun was worked out. (auth)

13847 EFFECTS OF IONIZING RADIATION ON DRUG-PROTEIN BONDS. E. Genazzani, M. di Rosa, and A. Graziani (Università, Naples). Chemotherapia, 6: 117-20(1963). (In Italian)

Experiments were conducted to determine the influence of x rays on the ability of bovine serum albumin to bind sulfathiazole. Binding was evaluated by the dialysis method of Klotz using pH 7.6 0.1M phosphate buffer. The protein concentration was 4% and Na sulfathiazole was added at concentrations of 3×10^{-4} to 3×10^{-3}. Dialysis was conducted for 72 hr at 5°C in 15 × 20 mm Visking sacs using 5 ml of protein solution and 10 ml of dialyzing fluid containing sulfathiazole. The protein solution was irradiated before dialysis with 15,000-, 60,000-, and 120,000-r doses of 230-kv x rays (0.5 mm Cu and 1.0-mm Al filtration) and 60,000-, 120,000-, and 240,000-r doses of unfiltered 50-kv x rays. No changes in the number of moles of sulfathiazole bound to the protein were noted under any of the conditions tested. Since it has already been noted that irradiation produces changes in the aromatic groups and sulfhydryl groups of proteins, it is concluded that the aromatic and sulfhydryl groups of bovine serum albumin are not directly involved in the formation of bonds in the reaction of the protein with sulfathiazole. (BBB)

13848 DISSOCIATION OF BUTANE MOLECULE IONS FORMED IN CHARGE EXCHANGE COLLISIONS WITH POSITIVE IONS. W. A. Chupka and E. Lindholm (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 25: 349-61(1964).

Mass spectra of butane were obtained after charge exchange with slow positive ions. The intensities of the peaks were plotted as a function of the energy absorbed by the molecule during the charge exchange. From the curves the electron impact mass spectrum can be obtained by integration using an energy distribution function with a high maximum at about 12 ev. Metastable ions were measured and the results are discussed. (auth)

13849 STUDIES OF THE SYNTHETIC INORGANIC ION EXCHANGER. II. THE PROPERTIES OF STANNIC PHOSPHATE. Yasushi Inoue (Tohoku Univ., Sendai). Bull. Chem. Soc. Japan, 36: 1316-23(Oct. 1963).

A recommended procedure for the preparation of stannic phosphate and a discussion of its ion exchange properties is presented. Stannic phosphate is a weakly acidic cation exchanger and possesses several dissociable hydrogen atoms in the range of pK_a values. In a weakly acidic solution, in which the exchanger is useful, the exchange group having the pK_a value of approximately three is most important. The affinity series for alkali metal coincides with the usual relationship observed in the ion exchange resin. The rate-determining step is assumed to be the migration of ions through the water retained in the gel structure. Stannic phosphate is unstable against heat treatment in air; that is, the separation of alkali metal does not go well with the exchanger dried at 110°C due to the slow rate of exchange. It is fairly stable against heat treatment in water; that is, it undergoes only a slight decrease in ion exchange capacity even when it is treated in water at 250°C for 8 days. It is stable against irradiation of about 10^9 r. The structure of stannic phosphate is suggested on the basis of its thermal decomposition curve, exchange capacity, titration curves, and x-ray-diffraction patterns. (P.C.H.)

13850 RADIOLYSIS OF CONCENTRATED AQUEOUS SODIUM NITRATE SOLUTIONS. J. Bednár and S. Lukác (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 29: 341-55(Feb. 1964). (In German)

The influence of dissolved materials on the radiolysis of concentrated sodium nitrate solutions was studied and

a mechanism for decomposition is proposed. In the system, ionization of the hydrated nitrate ion took place and reactions of excited water molecules and radicals with nitrate occurred. The yields from decomposition of concentrated solutions were not essentially different from the yield from aqueous decomposition. At the point of energy absorption, energy transfer to nitrate ions occurred. (tr-auth)

13851 MEASUREMENT OF THE RADIOACTIVITY OF TRITIUM-LABELED ORGANIC COMPOUNDS. Lien-sun Wang. Hua Hseuh Tung Pao, No. 12, 38-41(1963). (In Chinese)

Some of the more recent methods found to be suitable for measuring the activity of tritium-labeled compounds are reviewed. Gas-liquid chromatography is widely used to separate and to determine C^{14} and H^3 labeled organic compounds. The separation of the compounds and determination of their activity may be carried out simultaneously. High precision may be achieved by comparing the course of the radioactivity and thermal conductivity curves. The purity of the labeled organic compounds may be estimated on the basis of superimposed successive peaks of these two sets of curves. It was found possible to separate the radioactive compounds without making use of a carrier. Activities in the range of 10^{-18} to 10^{-9} curie can be determined with satisfactory precision. For best results, Geiger-Mueller counters filled with cyclohexane are recommended. The internal distribution of the radioactivity due to H^3 may be also determined. (TTT)

13852 RADIATION CHEMISTRY. Aryeh H. Samuel (Stanford Research Inst., Calif.). Ind. Res., 6: No. 3, 42-7(Mar. 1964).

The discovery, mechanisms, and uses of radiation chemistry are reviewed. Irradiation of dense media, dose yields, electron spin resonance spectra, chemical effects of radiations, and potential applications are discussed. (P.C.H.)

13853 HYDROLYSIS OF NEUTRON-IRRADIATED URANIUM MONOCARBIDE. M. J. Bradley, J. H. Goode, L. M. Ferris, J. R. Flanary, and J. W. Ullmann (Oak Ridge National Lab., Tenn.). Inorg. Chem., 3: 454(Mar. 1964).

The hydrolysis of uranium monocarbide specimens that had been irradiated to the relatively low level of 600 Mwd/mt of total U (0.06 atom % U burnup) yielded 96 ml (STP) of gas per g of carbide, consisting of 67 vol % methane, 28% hydrogen, and small quantities of higher hydrocarbons. In contrast, gaseous products from the hydrolysis of unirradiated specimens from the same batch of carbide as the irradiated specimens contained much more methane (88 vol %) and less hydrogen (9%). The results indicated that the effect observed with the irradiated specimens was not thermally induced. (P.C.H.)

13854 LIQUID SCINTILLATION COUNTING 1957-1963: A REVIEW. E. Rapkin (Packard Instrument Co. Inc., La Grange, Ill.). Intern. J. Appl. Radiation Isotopes, 15: 69-87(Feb. 1964).

A review is presented on developments in liquid scintillation counting from 1957 through 1963. Counting equipment, double-label counting, quenching, phosphors, solvents, suspension counting, suspended scintillators, paper strip counting, combustion and oxidation, inorganic samples, carbon dating, continuous flow measurement, and gases and vapors are discussed. 163 references are included. (P.C.H.)

13855 THE EFFECT OF THE METHOD OF PREPARATION ON THE LUMINESCENT YIELD OF PLASTIC SCINTILLATORS USING POLYSTYRENE. F. Heisel, G. Laustriat, and A. Coche (Faculté des Sciences, Strasbourg). Intern. J. Appl. Radiation Isotopes, 15: 89-93(Feb. 1964). (In French)

The effect of polymerization time on the luminescent yield of plastic scintillators and several monomer purification techniques are examined. The amount of residual styrene monomer and its effect on the scintillator's fluorescence spectra were also studied. (auth)

13856 A SIMPLIFIED METHOD FOR PREPARING HIGH SPECIFIC ACTIVITY I^{131}-LABELED HIPPURAN. L. J. Anghileri (Comision Nacional de Energia Atomica, Buenos Aires). Intern. J. Appl. Radiation Isotopes, 15: 95(Feb. 1964).

A method to obtain I^{131}-labeled Hippuran with specific activities up to 10 mC/mg is described. The method is based on the elimination of the remaining I^{131} iodide by exchange and deplacement, using silver chloride and silver iodide as absorbing agents. The radioactive yield is between 85-95%. (P.C.H.)

13857 THE EFFECT OF GAMMA RADIATION ON THE OXIDATION OF METHYL OLEATE IN THE PRESENCE OF INHIBITORS OF FREE RADICAL PROCESSES. E. V. Burlakova, N. I. Gorban, B. G. Dzantiev, G. B. Sergeev, and N. M. Emanuel (Moscow State Univ.). Izv. Vysshykh Uchebn. Zavedenii, Khim. i Khim. Tekhnol., 4: 751-4 (1961).

Samples of methyl oleate in the presence of free radical inhibitors were exposed to gamma radiation from Co^{60} and the destruction of the inhibitor was followed spectrophotometrically. Irradiation took place at 20°C. Oxidation experiments on irradiated and non-irradiated methyl oleate were carried out at 80°C with continuous passage of air. Experiments with inhibitor free methyl oleate were carried out simultaneously under identical conditions to obtain the rate of free radical formation. Curves showing the rate of free radical formation in inhibited and non-inhibited methyl oleate were found to be parallel and differed only in their induction period. The total induction period consists of the basic induction period for the oxidation of inhibitor free methyl oleate and an additional induction period related to the concentration of inhibitor; the latter is practically completely destroyed before free peroxide radicals are observed. The additional induction period is directly proportional to inhibitor concentration, which is characteristic of inhibitors reacting with radicals. Induction periods for the irradiated material were lower than for non-irradiated material due to inhibitor destruction, and the decrease in induction period was found to be proportional to the quantity of radiation. Curves showing the relation between inhibitor concentration and induction period, and the decrease in induction period of inhibited methyl oleate with total quantity of radiation, are given as well as correlating equations. It was found that quantity of radiation is controlling, and that intensity has virtually no effect. At the low temperature of radiation, the induction period of non-inhibited methyl oleate was practically unaffected by radiation. The correlation between the induction period of inhibited methyl oleate and the quantity of radiation made it possible to calculate the number of radicals formed per unit of radiation. Experiments, carried out in the presence and absence of oxygen respectively, lead to the suggestion that removal of a hydroquinone type inhibitor takes place essentially by reaction with an RO_2 type radical. (TCO)

13858 FORMATION AND REACTIONS OF RADIATION-PRODUCED ELECTRONS AND ATOMIC HYDROGEN IN γ-IRRADIATED ICE. L. Kevan, P. N. Moorthy, and J. J.

Weiss (King's Coll., Newcastle upon Tyne, Eng.). J. Am. Chem. Soc., 86: 771-6(Mar. 5, 1964).

Hydrogen atoms were found in γ irradiated ice at 77°K containing acid salts such as potassium dihydrogen orthophosphate and sodium bisulfate. It was found that they are also produced, although with lower yield, in ice containing neutral salts such as sulfates, phosphates, and carbonates. The hydrogen atom yields were found to be linear with solute concentration from 0.01 M up to saturated solutions and with radiation dose up to 8 megarads but attained a stationary value at about 15 megarads. Solutes that can act as scavengers for the radiation-produced electrons (polarons), such as nitrate, nitrite, acetone, and cupric salts, decreased the hydrogen atom yields in ices containing the mononegative ions, but were ineffective in the case of polynegative oxyanion solute. Relative rates of reactions of the electron with $H_2PO_4^-$ and competing scavengers such as nitrate and nitrite ions and acetone were determined. These reactions can be interpreted by the following mechanism: the radiation-produced electron reacts with an acid anion, such as, HSO_4 or $H_2PO_4^-$, either by electron or by proton transfer leading eventually to the formation of a hydrogen atom; in the case of the neutral salts, the stabilized hydrogen atoms are formed only from those water molecules that are in the solvation shells of the anions. (auth)

13859 IONIC INTERMEDIATES IN γ-IRRADIATED ORGANIC GLASSES AT −196°. John P. Guarino and William H. Hamill (Univ. of Notre Dame, Ind.). J. Am. Chem. Soc., 86: 777-81(Mar. 5, 1964).

Gamma irradiation at −196° of 3-methylpentane glasses containing alkene or aromatic solutes produces three types of color centers. One of these is attributable to solvated electrons or to solute anions. Another can be identified as positive ions of the solutes that appear to be formed through charge transfer from solvent. The third type correspond to free radicals. Absorption bands arising from carbon tetrachloride and other alkyl halide solutes are also attributed to cations in irradiated glasses. The efficiency of positive charge transfer is less than that for electron capture by solutes. Yields of cations are enhanced by solutes that attach electrons. (auth)

13860 PHOTOPOLYMERIZATION OF ACRYLONITRILE IN THE PRESENCE OF LANTHANUM SALTS. Cristofor Simionescu, Dorel Feldman, and Spiridon Oprea (Institut Politechnique, Jassy, Rumania). J. Appl. Polymer Sci., 8: 447-54(Jan. 1964). (In French)

Data are given for the photopolymerization of acrylonitrile in the presence of some lanthanum salts, as initiators of the polymerization. The activity of the salts with respect to the photopolymerization of acrylonitrile indicates the following series: $LaCl_3 \cdot H_2O > La_2(SO_4)_3 \cdot 9H_2O > La(NO_3)_3 \cdot 6H_2O > La(CH_3COO)_3$. The kinetics of the process were also considered. (auth)

13861 EFFECT OF ATMOSPHERE ON RADIATION-INDUCED CROSSLINKING OF POLYETHYLENE. PART IV. SENSITIZING EFFECT OF NITROUS OXIDE AND XENON. Yoichi Okada (Sumitomo Bakelite Co., Ltd., Yokohama, Japan). J. Appl. Polymer Sci., 8: 467-73(Jan. 1964).

Low density polyethylene film was irradiated with gamma rays from Co^{60} in atmospheres of nitrous oxide and xenon. A plot of solubility ($S + S^{0.5}$) against reciprocal of irradiation dose gives a nearly straight line in each case. The probability of crosslinking increases by 44% in N_2O as compared with vacuum irradiation, and increases by 10% in Xe. On the other hand, the probability of main-chain scission is scarcely affected by the gases. Therefore the increase in gel fraction due to the gases is not due to the protection against main-chain scission, but is caused mainly by the sensitization against crosslinking. Furthermore, the formation of trans vinylene unsaturation is also sensitized by the gases. (auth)

13862 HYDRIDE AND PROTON TRANSFER REACTIONS INVOLVING SEC-PROPYL IONS. R. P. Borkowski and P. Ausloos (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 40: 1128-32(Feb. 15, 1964).

The reactions of sec-propyl ions produced in the radiolysis of $n\text{-}C_4D_{10}$ and $i\text{-}C_4D_{10}$ with hydrocarbons were investigated. When the additive (RH) is a saturated hydrocarbon, the hydride transfer reaction: $C_3D_7^+ + RH \rightarrow C_3D_7H + R^+$ is the major mode of reaction. For straight chain hydrocarbons, the cross section of this reaction, relative to that of the reference reaction $C_3D_7^+ + C_4D_{10} \rightarrow C_3D_8 + C_4D_9^+$ is shown to increase with the molecular weight of RH. For different hydrocarbon isomers, the relative cross section of the hydride transfer reaction decreases with an increase in branching while the analogous reactions involving ethyl ions show no such discrimination. From the isotopic analysis of the propanes and propylenes produced in the radiolysis of C_4D_{10} carried out in the presence of olefins, it was concluded that the proton transfer reaction $C_3D_7^+ + RH \rightarrow C_3D_8 + RHD^+$ occurs. Comparison of the data obtained, using C_3D_8, $n\text{-}C_4D_{10}$, and $i\text{-}C_4D_{10}$ as sources of ethyl or propyl ions, indicated that the relative cross sections of the hydride transfer reactions are independent of the origin of the carbonium ion. (auth)

13863 ELECTRON SPIN RESONANCE OF GAMMA-RAY IRRADIATED SINGLE CRYSTALS OF SODIUM NITRITE. Jun Tateno and Kazuo Gesi (Japan Atomic Energy Research Inst., Tokyo). J. Chem. Phys., 40: 1317-21(Mar. 1, 1964).

Single crystals of sodium nitrite were irradiated with Co^{60} gamma rays of about 10^9 r at room temperature and studied by ESR method. The spectrum consists of a triplet and a quintet associated with different paramagnetic species; the former is believed to be NO_2 and the latter $N_2O_4^-$. From the analysis of the anisotropy of the hyperfine tensor the molecular plane of NO_2 lies in the crystal ac plane. Molecular orbital of the unpaired electron of $N_2O_4^-$ was also calculated. (auth)

13864 THERMOLUMINESCENT KINETICS OF ALPHA-IRRADIATED ALKALI HALIDES. C. E. May and J. A. Partridge (Lewis Research Center, Cleveland). J. Chem. Phys., 40: 1401-9(Mar. 1, 1964).

The kinetics of the thermoluminescence of single crystal NaCl, KCl, and KBr irradiated with 40-Mev alpha particles were investigated. Only one glow peak, composed essentially of a single emission band, was obtained for each of the salts investigated. To attempt complete analysis of the kinetics, both glow curve and isothermal annealing experiments were employed. The results from glow curves were shown to be unreliable for calculation of the kinetic order in the case of NaCl and KBr. The isothermal tests indicate the kinetics of the dominant process for NaCl to be first order; for KBr, first order; and for KCl, ½ order. No general statement can be made concerning the order of these processes; thus, at present, the kinetics for each salt investigated must be determined individually. Occasionally, secondary processes occur in specimens of NaCl and KBr, even though essentially only one spectral peak was detected. A simple model for luminescence will explain the kinetics of NaCl and KBr; it involves activation of electrons from traps into the conduction band. To ex-

plain the results for KCl, a more complex model is required. Activation energies were also calculated. (auth)

13865 ROLE OF BENZENE IN THE RADIOLYSIS OF CYCLOHEXANE–BENZENE MIXTURES. J. G. Burr and F. C. Goodspeed (Atomics International, Canoga Park, Calif.). J. Chem. Phys., 40: 1433-6(Mar. 1, 1964).

Benzene consumption, G(-benzene), was measured in irradiated cyclohexane solutions containing 1, 5, and 10% benzene as a function of dose from 8×10^{20}–80×10^{20} ev/g. G(-benzene) was found to decrease with increasing dose and to be approximately proportional to the square root of the initial benzene concentration. The composition of the polymer and dimer fractions obtained in the radiolysis of cyclohexane-5%–benzene-C^{14} mixtures shows that 25% of the consumed benzene appears as phenylcyclohexane and the rest as polymer. The magnitude of the G(-benzene) values suggests that radical scavenging by benzene is significant, although not the most important interaction. (auth)

13866 RADIATION CHEMISTRY OF CARBOHYDRATES. PART XIII. ACTION OF γ-RADIATION ON OXYGENATED SOLUTIONS OF MALTOSE. G. O. Phillips and K. W. Davies (University Coll., Cardiff, Wales). J. Chem. Soc.: 205-12(Jan. 1964).

When maltose is irradiated with Co^{60} γ radiation in oxygenated solution, the predominating initial process is a hydrolytic type of scission to glucose. There is accompanying oxidative scission, to yield gluconic acid. Maltobionic acid and an additional disaccharide acid, probably formed by oxidation of a 6-$CH_2 \cdot OH$ group, are also initial products. Radioactive-tracer and paper-chromatographic methods were used to obtain yield-dose curves for the products and to measure the rate of degradation of maltose (initial –G 4.0), which is of the first order in maltose. Secondary degradative processes lead to additional products at doses higher than 2×10^{20} ev ml^{-1}. The effect of maltose concentration on the radiative decomposition was examined, and possible mechanisms are discussed. A post-irradiation process leads to the formation of acid, reduction in hydrogen peroxide, and decrease in intensity of the ultraviolet absorption at 267 mμ. The after-effect is shown to be a thermal reaction due to hydrogen peroxide. (auth)

13867 EFFECT OF GAMMA RADIATION ON LACTOSE. I. SOME PROPERTIES OF A REDUCTONE FORMED IN IRRADIATED LACTOSE SOLUTION. Sasumu Adachi (Pennsylvania Agricultural Experiment Station, University Park). J. Dairy Sci., 45: 962-8(Aug. 1962).

Irradiation of carbohydrates causes the formation of a substance that shows strong reducing capacity for 2,6-dichlorophenol indophenol reagent; it is generally called a reductone. The results of isolation and characterization of a reductone from γ-irradiated lactose solution are described. A 0.15M lactose solution was exposed to 2 Mrep. The irradiated lactose solution reduced alkaline 2,6-dichlorophenol indophenol and phospho-18-tungstate reagents. It also showed a specific absorption spectrum in the ultraviolet region, the maximum wavelength of which was shifted to longer wavelengths, and the maximum specific extinction coefficient was increased with decreasing hydrogen ion concentration. A substance detected on paper chromatograms obtained by multiple development using butanol, acetic acid, and water (4:1:5) showed the same characteristics as those of the irradiated lactose solution. From the available data on this substance isolated by large-scale paper chromatography, it was tentatively concluded that some reductone-like properties of the irradiated lactose solution can be ascribed to this substance, termed a reductonate. This compound may be involved in the browning of irradiated milk. (BBB)

13868 SPECTRAL PROPERTIES OF RARE EARTH OXIDE PHOSPHORS. R. C. Ropp (Sylvania Electric Products Inc., Towanda, Penna.). J. Electrochem. Soc., 111: 311-17(Mar. 1964).

A study of rare earth oxide phosphors activated by rare earths revealed that fluorescence occurs only in those matrices where the cation possesses no unpaired electrons. The fluorescent intensities of the rare earth activators were divided into three categories, strong, medium, and weak, each having a characteristic excitation spectrum. (auth)

13869 AN INVESTIGATION INTO THE EFFECTS OF GAMMA-RAYS ON AQUEOUS SOLUTIONS OF p-AMINOBENZOIC ACID. P. H. Marriott (Univ. of Manchester, Eng.). J. Pharm. Pharmacol., 15: 666-70(Oct. 1963).

Aqueous solutions of p-aminobenzoic acid (0.3%) were irradiated with gamma-rays under both oxygen-saturated and oxygen-free conditions. By means of paper chromatography, p-nitrobenzoic acid was isolated from the irradiated, oxygenated aqueous solution and 4-amino-3-hydroxybenzoic acid isolated from the irradiated, oxygen-free aqueous solution. The products were probably produced by indirect action of the Co^{60} gamma-rays. (auth)

13870 RADIOISOTOPE IRRADIATION SOURCES FOR RADIATION CHEMISTRY. Josef Šimorda (Inst. of Rubber and Plastic Tech., Gottwaldov, Czechoslovakia). Jaderna Energie, 9: 379-85(Dec. 1963). (In Czech)

A brief review of irradiation sources using radioisotopes for various processes in radiation chemistry and technology is given. The sources are described and the problems of economic operation are discussed. (auth)

13871 RADIATION PROCESS FOR SYNTHESIS OF ETHYLENE GLYCOL AND FORMALDEHYDE FROM METHANOL. Khon-sil Kim, A. V. Zimin, and V. A. Sharpati. Khim. Prom., No. 7, 12-15(1963).

A study was made of the feasibility of commercial-scale production of ethylene glycol (I) and formaldehyde (II) from pure anhydrous methanol (0.1% H_2O) and aqueous methanol by a radiation process in a circulation-flow system. Data from two series of experiments are presented: irradiation of methanol under static conditions with γ-rays from a Co^{60} source at a low dose rate ($1.1-1.2 \times 10^{14}$ ev/ml · sec) at 20 and 200°C, in vacuo or in the presence of oxygen at 20°C; and irradiation at a high dose rate ($12-40.0 \times 10^{17}$ ev/ml · sec) in the circulation-flow system of liquid methanol (at 20°C) with fast electrons (140–170 kev) or of solid methanol (at –180 to –140°C) with fast electrons (about 1.6 Mev). In the case of γ irradiation in vacuo, the change in temperature had practically no effect on the G-value for I and II. The presence of oxygen decreased the G-value for I and increased it for II. The presence of water (up to 30%) had no appreciable effect on the degree of conversion of methanol. Computations indicate that at $G_{CH_3OH} = 10.7$, the degree of conversion of methanol to I and II was about 70 and 20%, respectively. In both the static and the circulation-flow methods, the G-value for I increased with dose rate, but the increase was more marked for the latter, evidently owing to the removal of end products from the irradiation zone. An observed decrease in the G-value for II with increased integral dose in both methods is attributed to partial polymerization of II as its concentration increases. The formation of I is assumed to proceed both by the interaction of the free radicals formed and by the interaction of excited and unexcited molecules of I. EPR spectra of the

irradiated solid methanol indicate the formation of CH_2OH and CH_3O free radicals as the main intermediate products in the radiolysis. Various gamma and beta radiation sources, including a nuclear reactor, may be used for the production of I and II by the circulation-flow method. (OTS)

13872 RADIATION-INDUCED OXIDATION OF TETRAFLUOROETHYLENE BY OXYGEN. V. Caglioti, M. Lenzi, and A. Mele (CNEN, Rome and Università, Rome). Nature, 201: 610-11(Feb. 8, 1964).

A one-to-one mixture of oxygen and tetrafluoroethylene was subject to gamma and x radiation, and the resulting oxidation products were studied. (R.E.U.)

13873 EFFECTS OF γ-IRRADIATION ON THE STABILITY OF BARIUM SULFATE SOL. Hitoshi Fujita and Masami Izawa (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Kagaku Zasshi, 84: 779-83(Oct. 1963). (In Japanese)

Gamma irradiation effects on the stability of $BaSO_4$ sol were investigated. The sol was prepared by the reaction of K_2SO_4 and $BaCl_2$ in the presence of sodium citrate. Dialyzed and diluted sol was irradiated with Co^{60} γ rays at a dose rate of 7000 r/min. Stability of the irradiated sample was determined by measuring the turbidity of supernatant after standing for 24 hr at room temperature. The sol irradiated above a certain dose under O_2 bubbling became remarkably unstable. The critical dose necessary to coagulate the sol (critical coagulation dose) was proportional to the initial concentration of citrate, which was potential-determining ion of the sol. The concentration of citrate in the sol decreased with increasing dose. Electrophoretic mobility of $BaSO_4$ also decreased with increasing dose. At the critical coagulation doses, sols showed the same remaining amounts of citrate per unit weight of $BaSO_4$ and the same mobilities irrespective of the initial concentrations of $BaSO_4$ and citrate. In cases of irradiation under N_2-bubbling, the radiolysis rate of citrate was lower than that in oxygenated sols and, therefore, the sols were not coagulated at the critical coagulation-doses for oxygenated sols. (auth)

13874 RADIOLYSIS ETHYLENEDIAMINETETRAACETATOCOBALTATE(III) IN AQUEOUS SOLUTION. Niro Matsuura, Nobuyoshi Shinohara, and Masao Takizawa (Tokyo Univ.). Nippon Kagaku Zasshi, 84: 897-902(Nov. 1963). (In Japanese)

The radiolysis of ethylenediaminetetraacetatocobaltate (III) (Co^{III} EDTA) in 0.8N sulfuric acid medium was investigated. Co^{III} EDTA is readily reduced to Co(II) state by γ irradiation, but the reduction is followed by the decomposition of ligand molecule, ethylenediaminetetraacetic acid(EDTA). The decomposition product of Co^{III} EDTA was a Co(II) compound chelated with degraded EDTA. The decomposition yields of this complex in the presence and absence of dissolved oxygen were 2.5 and 5.0, respectively, in G value, and those of EDTA alone in the presence and absence of dissolved oxygen were 3.6 and 4.0, respectively. According to the radical diffusion theory, the decomposition mechanisms were discussed stoichiometrically. (auth)

13875 THE PREPARATION OF Y^{90} FOR THERAPEUTIC APPLICATION. H. R. von Gunten, W. Scherle, and H. Huegli (Eidgenössische Institut für Reaktorfurschung, Wurenlingen, Switzerland). Nucl. Med., 3: 417-25(1963). (In German)

A method of preparing Y^{90} suitable for therapeutic purposes is described. Y^{90} is separated from Sr^{90} using di-(2-ethyl hexyl) orthophosphoric acid with subsequent cleaning. Y^{90} is then co-precipitated with $Fe(OH)_3$ and is ready for use. The purity of the product is controlled by the procedure of ion exchange focusing. The method yields a Y^{90} with a radiochemical purity greater than 99.9999 per cent; the decontamination factor with respect to Sr^{90} is greater than 10^6. The half-life of the Y^{90} was determined, and a value of 63.74 ± 0.1 hr was obtained. The yield of Y^{90} was between 95 and 99 per cent. (auth)

13876 THE RADIATION INDUCED OXIDATION AND REDUCTION REACTIONS OF IRON IN AQUEOUS SOLUTIONS. V. THE DIRECT OBSERVATIONS OF REDOX PROCESSES IN THE IRRADIATED $Fe-H_2SO_4$-ISOBUTYL ALCOHOL-H_2O-O_2 SYSTEM. THE EFFECT OF THE CONCENTRATIONS OF Fe^{2+} AND Fe^{3+} IONS AND OF ISOBUTYL ALCOHOL. Roman Broszkiewicz (Inst. of Nuclear Research, Warsaw). Nukleonika, 8: 617-25(1963).

The effects of the concentrations of ferric and ferrous ions, isobutyl alcohol, and oxygen on the radioinduced oxidation and reduction reactions of the iron ions were observed during the irradiation. Measurements were taken in 0.1N H_2SO_4 solutions. The results point out the importance of the concentration of ferrous ions in reactions terminating the chain as well as that of alcohol in reactions of the reduction of ferric ions. The steady-state, observed at low concentrations of the ferrous ions, may be attributed to the presence of oxygen inhibiting the reduction. A decisive factor on the whole process of oxidation and reduction turns out to be oxygen, whose presence helps to start the oxidation of ferrous and absence enables the reduction of the ferric ions. (auth)

13877 THE RADIATION INDUCED OXIDATION AND REDUCTION REACTIONS OF IRON IN AQUEOUS SOLUTIONS. VI. THE DIRECT OBSERVATION OF REDOX PROCESSES IN THE IRRADIATED $Fe-H_2SO_4$-ALCOHOLS-H_2O-O_2 SYSTEM. THE EFFECTS OF THE STRUCTURE OF ALCOHOL. Roman Broszkiewicz (Inst. of Nuclear Research, Warsaw). Nukleonika, 8: 627-34(1963).

The processes of the oxidation of ferrous and reduction of ferric ions in the irradiated solutions consisting of $Fe(NH_4)_2(SO_4)_2$, H_2SO_4, and primary, secondary, or tertiary alcohols were investigated. The solutions were not deoxygenated. According to the spectrophotometric measurements taken directly during the irradiation it was observed that, at the concentrations applied, the processes of ferrous oxidation are relatively independent on the type of alcohol. The processes of the reduction of ferric ions proceed easier when the alcohol is more polar or is composed of a less number of H-atoms attached to the C-1 carbon, in the case of secondary or simple primary alcohols. The lack of H-atoms at the C-1 carbon considerably diminishes the reduction that happens in the case of tertiary alcohols. The decrease of polarity of a molecule of alcohol following the increase of the carbon chain, causes the decrease of G_{red} of ferric ions, which for the higher alcohols reaches the same value as for hydrocarbons. (auth)

13878 THE RADIATION INDUCED OXIDATION AND REDUCTION REACTIONS OF IRON IN AQUEOUS SOLUTIONS. VII. THE DIRECT OBSERVATION OF REDOX PROCESSES IN THE IRRADIATED $Fe-H_2SO_4$-CARBOXYLIC ACIDS-H_2O-O_2 SYSTEM. THE EFFECTS OF THE STRUCTURE OF ACIDS. Roman Broszkiewicz (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 641-8(1963).

The effects of the structure of a carboxylic acid on the processes of oxidation and reduction of iron ions in irradiated aqueous solutions were directly observed during irradiation. The solutions contained the mono- or dicarboxylic acid, H_2SO_4, $Fe(NH_4)_2(SO_4)_2$ and O_2. The ferrous oxidation

was rather independent of the acid and its concentration, but the reduction of ferric was possible in the presence of formic, oxalic, or valeric acid only. The radical formed from the valeric acid acts similar to those formed from hydrocarbons. The G-values of oxidation and reduction of the iron ions were established. The molar extinction coefficients for oxalic and malonic complexes of ferric ions were determined. (auth)

13879 EFFECTS OF THE C-14 β-RAYS ON KINETICS OF THE ESTERIFICATION PROCESS. Alicja Dorabialska, Witold Swiatkowski, and Stefan Tilk (Lodz Technical Univ., Poland). Nukleonika, 8: 673-9(1963). (In Polish)

Kinetics of the esterification of ethanol with acetic acid was investigated by the conductometric method. In the first series of experiments normal acetic acid and in the second acetic acid labeled with C-14 in carboxyl group were used. The specific activity of the reacting solution was 0.01545 mC/ml. The initial concentrations of the reagents were the same and equal each other (5 mole l^{-1}) in all experiments. The temperature was maintained at 25.0 ± 0.1°C and the measurements were carried out during 10-14 days. The obtained conductivity-time kinetic curves are of the second order if the normal acetic is used (the rate constant $k = 8.9 \times 10^{-5} \mp 1\%$ l h^{-1} mol^{-1}). In the presence of C^{14} during the first 170 hours of the reaction, conductivity change does proceed according to the second order rate law. The kinetic curves are steeper. The facts were interpreted as the effect of β rays causing the radiolysis of acetic acid to non-ionic products in about 2.37%. It is believed that no one of these products acts as the catalyst. (auth)

13880 MECHANISM OF ENZYME INACTIVATION BY ULTRAVIOLET LIGHT AND THE PHOTOCHEMISTRY OF AMINO ACIDS (AT 2537 Å). R. A. Luse and A. D. McLaren (Univ. of California, Berkeley). Photochem. Photobiol., 2: 343-60(Aug. 1963).

The inactivation of the enzymes chymotrypsin, lysozyme, ribonuclease, and trypsin by ultraviolet light can be accounted for quantitatively by summing the products of the probability that light is absorbed by a given amino acid residue, the molecular extinction coefficient, and the probability that absorbed light induces a chemical change in the residue, the quantum yield for the residue. The principal residues involved are cystyl and tryptophanyl. Peptide bond rupture is not important. Energy transfer among chromophores within molecules of enzymes need not be invoked in order to account for photochemical inactivation. Quantum yields for the destruction of a number of amino acids at 2537 Å were measured. (auth)

13881 PHOTOCHEMISTRY OF 4-AMINOPYRIMIDINES: 2,6-DIMETHYL-4-AMINOPYRIMIDINE. K. L. Wierzchowski and D. Shugar (Inst. of Biochemistry and Biophysics, Warsaw). Photochem. Photobiol., 2: 377-91(Aug. 1963).

Ultraviolet irradiation (2537 Å) of 2,6-dimethyl-4-aminopyrimidine (I) results in an intramolecular rearrangement with the formation, either in aqueous or anhydrous medium, of only one photoproduct, 2-amino-3-cyanopent-2-en-4-imine (II), in quantitative yield. The quantum yield for this reaction is 0.043 einsteins/mole. Deamination of II gives, quantitatively, 2-amino-3-cyanopent-2-en-4-one (III) and this, in turn, may be deaminated to give, quantitatively, 3-cyanopent-2-en-2-ol-4-one(cyanoacetylacetone, IV). Identification of II was achieved initially through isolation of III and IV. Some of the chemical and physico-chemical properties of these compounds are reported, as well as methods for obtaining all of them on a preparative scale. The mono-protonated form of I also gives II on irradiation, but in lower quantum yield, 7.3×10^{-3} einsteins/mole. Irradiation of the doubly protonated form of I in strongly acid medium leads directly to the formation of a mixture of II, III, and IV, with approximately the same quantum yield. The possible mechanisms for the foregoing photochemical reactions are discussed and their significance related to the photochemistry of 4-aminopyrimidines in general and to those of nucleic acid derivatives in particular. (auth)

13882 PHOSPHORESCENCE DECAY OF X-RAY IRRADIATED KCl:Tl PHOSPHORS. R. V. Joshi (University, Baroda, India). Phys. Chem. Solids, 25: 135-9(Jan. 1964).

Measurements were made at room temperature on the phosphorescence decay rates of KCl:Tl phosphors exposed to x irradiation. The effects of pressure and heat treatment on the decay rates were studied independently. The decay mechanism as the result of successive x irradiations of varying durations is also discussed. It is suggested that the decay occurs primarily through the thermal bleach of the phosphor in which a photoelectron released from a single negative ion vacancy recombines with the Tl emission center in its close proximity. The negative ion vacancies may be present in the base material either initially or generated in it by pretreatment. (auth)

13883 DISLOCATION BOUNDARIES IN IRRADIATED SODIUM NITRATE SINGLE CRYSTALS. R. G. Di Martini and J. G. Byrne (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Chem. Solids, 25: 147-8(Jan. 1964).

Irradiation of sodium nitrate crystals produced cleavage step patterns typical of dislocation boundaries whereas in nonirradiated crystals the distribution of cleavage steps was random. A tentative explanation of the occurrence of such boundaries is given. (P.C.H.)

13884 FIELD QUENCHING AND ENHANCEMENT IN ZnS AND CdS PHOSPHORS. K. N. R. Taylor (Univ. of Durham, Eng.). Phys. Status Solidi, 4: 207-36(1964).

The effects produced by the simultaneous application of more than one type of stimulus to phosphor materials are reviewed. The observed phenomena induced by the presence of an electric field during stimulation are discussed. It was found that in general when a steady, alternating, or pulsed electric field is applied to a phosphor in the form of a powder, film, or single crystal, excited with ultraviolet light, x rays, cathode rays, or α particles, a quenching of the emitted light occurs. However, for some conditions such as manganese activation and chlorine coactivation, an increase in the luminescence intensity can be induced by the field. It is possible for both enhancement and quenching to be observed in a single specimen and for the spectral dependence of the effects to change with field frequency, illumination intensity, and temperature. Field-induced processes in ZnS and CdS phosphors are described. Theoretical explanations are presented. (M.C.G.)

13885 THE INTERACTION OF RADIOLYTICALLY PRODUCED UNIVALENT TRANSITION-METAL IONS WITH WATER. M. Anbar and D. Meyerstein (Israel Atomic Energy Commission, Rehovoth). Proc. Chem. Soc., 23-4 (Jan. 1964).

The interaction of manganese ions with hydrated electrons was investigated along with the products of the reaction. 2-deuteropropan-2-ol (0.04 M in H_2O) was irradiated by Co^{60} x rays at a dose rate of 11,800 rad/min, and the isotope composition of the hydrogen produced was determined mass spectrometrically. The yield of hydrogen atoms was monitored by the HD formed. The effects of Mn and other ions on the yield of HD were studied. Mn^{2+} ions decreased the ratio HD:H_2 by a factor >20. The total yield of hydrogen was, however, not decreased. The effect of Mn on the HD:H_2 ratio can be explained by the formation of

hydrogen from water, presumably involving the transfer of a hydride ion. (P.C.H.)

13886 RADIATION INDUCED SOLID STATE POLYMERIZATION. George Adler (Brookhaven National Lab., Upton, N. Y.). Proc. Symp. High Power Accelerator Appl., New York, 1961, 68-78(1962).

It has been known that radiation can induce polymerization in a number of solid monomers. The most thoroughly studied of these monomers is acrylamide. It was shown that the polymerization will continue for extremely long periods of time even after removal of the monomer from the radiation source. The polymer formed is amorphous and unoriented. This is explained by assuming that the polymer nucleates as a second phase and that reaction then occurs at the interface between monomer and polymer. In this way, the polymer can become amorphous. Theoretical considerations, backed by some experimental work, indicate that the nucleation takes place at a very early stage of the reaction, when the polymer chain consists of just a few monomer units. The most favorable site for nucleation is along crystal defects. This mechanism is supported by a good deal of experimental work using electron spin resonance, x-ray diffraction, microscopy, and other techniques. Included with these was the taking of a series of time-lapse movies that show the course of reaction quite plainly. (auth)

13887 SEPARATION OF RADIOACTIVE CARRIER-FREE SILVER ISOTOPES FROM FISSION PRODUCTS OF HEAVY NUCLEI. R. V. Sedletskii and V. A. Shibaev. Radiokhimiya, 5: 635-7(1963). (In Russian)

A method was developed for separating carrier-free Ag isotopes from U^{238} fission products. The products exhibited a high radiochemical purity and were free of salt impurities. The radiochemical analysis took 5 to 6 hrs and the yield was 25%. (R.V.J.)

13888 STABILIZATION OF ELECTRONS IN THE LOW-TEMPERATURE RADIOLYSIS OF ORGANIC SUBSTANCES. V. G. Nikol'skii, V. A. Tochin, and N. Ya. Buben (Inst. of Chemical Physics, Moscow). Soviet Phys.-Solid State (English Transl.), 5: 1636-41(Feb. 1964).

A study was made of the photoluminescence excitation spectra of some saturated hydrocarbons irradiated with fast electrons at 77°K. The absorption spectra of irradiated polyethylene samples were investigated at low temperatures, as well as the dependence of the absorption coefficient on the radiation dose. The results obtained indicate that in samples of saturated hydrocarbons, low-temperature radiolysis produces localized centers, the energy levels of which lie 2-3 ev below the conduction band. (auth)

13889 FORMATION OF COLORED M-CENTERS IN KCl SINGLE CRYSTALS. T. Sh. Davitashvili. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 9: 153-7(1963). (In Russian)

The formation of colored M-centers at the optical dissociation of F-centers was studied for KCl crystals irradiated by x rays. On the basis of the experimental results a conclusion is made that M-centers (according to F. Seitz's model) can arise only when there are threes of vacancies $V_2(\alpha)Vk$ which localize the free electrons. (The lifetime (stability) of these threes of vacancies determines the possibility of M-centers formation.) (auth)

13890 POLYMERIZATION AND SYNTHESIS OF GRAFT POLYMERS FROM NATURAL RUBBER AND FROM POLYSTYRENE BY GAMMA IRRADIATION. Kh. U. Usmanov, R. S. Tillaev, U. N. Musaev, and D. Tursunov (Tashkent State Univ.). Tr. Tashkentsk. Konf. po Mirnomu Ispol. At. Energii, Akad. Nauk Uz. SSR 1(1959), 298-302 (1961).

The synthesis and properties of graft polymers from natural rubber with vinyl chloride and from polystyrene with acrylonitrile were studied and the synthesis of homopolymers by radiation polymerization of acrylonitrile, vinyl chloride, and furfuryl alcohol was investigated. The radiation polymerization of ethylene and of vinyl polymers was studied. Ampoules filled with a mixture of natural rubber and vinyl chloride were irradiated. The polymer resulting from gamma irradiation is not soluble, but swells slightly in some solvents (benzene, toluene, carbon tetrachloride, methylene chloride) and some solvent mixtures. The polymer obtained by grafting and irradiation has a more strongly ramified chain than the original rubber with a netlike structure resistant to solvents. The maximum amount of absorbed liquid per gram of polymer and the swelling rate constant drop a little with increasing dose. All graft polymers from natural rubber and vinyl chloride are more heat-resistant than the initial rubber. The mechanical properties and the electrical insulating quality of additionally vulcanized grafted rubber meet specified requirements on insulating rubber for the cable industry. The graft polystyrene polymer with acrylonitrile was produced by gamma irradiation ($1.10^6 - 4.10^6$ r) of a swelled polystyrene film. The amount of nonreacting polystyrene and of the copolymer drops with increasing radiation dose. The thermal resistivity of the initial and of the graft polymer is increased by the grafting of polystyrene with acrylonitrile. In addition, the graft polymer is more resistant to solvents than the initial polymer. Irradiation of acrylonitrile and vinyl chloride (starting material for the production of graft polymers) yielded polyacrylonitrile, polyvinyl chloride, and polyfurfuryl alcohol. (TCO)

13891 RADIATION POLYMERIZATION IN THE SOLID PHASE. I. POLYMERIZATION OF ACRYLONITRILE. I. M. Barkalov, V. I. Goldanskii, N. S. Enikolopyan, S. F. Terekhova, and G. M. Trofimova. Vysokomolekul. Soedin., 6: 92-7(Jan. 1964). (In Russian)

The kinetics of acrylonitrile (AN) polymerization induced by fast electrons with an energy of 1.6 Mev were investigated over the temperature range −196 to 0°C. Calorimetric determinations showed that solid phase polymerization of AN, excepting slow post-effects occurs directly in the solid phase and not in the course of the following thawing process, despite the fact that the shape and intensity of the EPR signal appearing during irradiation is retained after its interruption. There is practically no activation energy of the solid phase polymerization. From −196 to −150° yield limit is observed at large doses and there is no post-effect. Post polymerization takes place from −140°C until the melting point, the activation energy of this process being 3 kcal/mole. The specific features of solid phase polymerization in the course of irradiation may be due to the effective participation of short lived excited states in the propagation of the energy chains or change in state of the solid during irradiation. (auth)

13892 STRUCTURAL CONVERSIONS OF POLYETHYLENE OF THE IRRADIATION AND THERMAL TREATMENT. Z. A. Markova, B. G. Ershov, and N. A. Bach. Vysokomolekul. Soedin., 6: 131-4(Jan. 1964). (In Russian)

Structural changes in polyethylene subjected to irradiation under vacuum followed by oxidation in air and pyrolysis under vacuum were investigated with the aid of infrared spectroscopy. A new (apparently three-dimensional) structure was found to form in polyethylene as the result of

such treatment. In this structure carbonyl and aromatic compounds with high degree of conjugation of C=C and C=O bonds are predominant. (auth)

13893 ENERGY TRANSFER BETWEEN HYDROCARBONS AND METAL CARBONYLS. II. REPORT ON RADIOCHEMICAL INVESTIGATION OF METAL CARBONYLS. Helmut Barzynski and Dieter Hummel (Universität, Cologne). Z. Physik. Chem. (Frankfurt), 39: 148-59(Nov. 1963). (In German)

The effects of Co^{60} gamma radiation on mixtures of cyclohexane with iron pentacarbonyl or nickel tetracarbonyl were investigated. The G values of the most important reaction products, cyclohexene, dicyclohexyl, carbon monoxide, iron monocarbonyl, iron dodecacarbonyl, and elementary nickel, were determined in relation to their dependence on mixture content and the absorbed radiation energy. The results obtained showed that the energy primarily absorbed by the cyclohexane is in part transferred from the metal carbonyl. A kinetic consideration yielded insight into the mechanism of the reaction. (tr-auth)

13894 SPECTRAL ANALYSIS OF HIGH-PURITY GRAPHITE. L. B. Gorbunova, E. S. Kon'kova, and A. F. Kuteinikov. Zavodsk. Lab., 30: 38-9(1964). (In Russian)

A method is developed for the spectral determination of admixtures in high purity graphite by means of partial ashing of the specimen with a sodium chloride carrier. The sensitivity of the analysis is 1 to 3×10^{-6}%, with a relative error of about 15%. (tr-auth)

13895 PREPARATIVE RADIATION CHEMISTRY OF TRANSITION METAL COMPLEXES. E. Koerner von Gustorf, M.-J. Jun, H. Koeller, and G. O. Schenck (Max-Planck-Institut für Kohlenforschung, Mülheim, Ger.). p.73-85 of "Industrial Uses of Large Radiation Sources. Vol. II." Vienna, International Atomic Energy Agency, 1963.

Radiation chemical synthesis of transition metal π-complexes was studied. Examples are the preparation of maleic-acid-anhydride-iron-tetracarbonyl, fumaric-acid-dimethylester-iron-tetracarbonyl, methacrylic-acid-methylester-iron-tetracarbonyl, vinylacetate-iron-tetracarbonyl, etc., by Co^{60} γ-irradiation of $Fe(CO)_5$ and the corresponding unsaturated compounds. Chemical reactions of the formed π-complexes were investigated. Examples are the polymerization of vinyl compounds at room temperature by the action of organic halogen compounds on complexes such as methacryl-acid-methylester-iron-tetracarbonyl, vinylacetate-iron-tetracarbonyl, etc. Synthesis of π-complexes and carbonyl compounds of transition metals by irradiation was also studied. Examples are the Co^{60} γ-irradiation of $[(C_5H_5)_2Fe]$, $[(C_5H_5)_2Ni]$, $CH_3C_5H_4Mn(CO)_3$, $(C_5H_5)TiCl_2$, $Fe(CO)_5$, $Ni(CO)_4$, in halogen hydrocarbons. (auth)

13896 RECENT RESULTS ON THE FIXATION OF ATMOSPHERIC NITROGEN BY REACTOR RADIATION. D. A. Landsman and M. J. Davies (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.123-37 of "Industrial Uses of Large Radiation Sources. Vol. II." Vienna, International Atomic Energy Agency, 1963.

An attempt was made to determine the conditions under which the maximum yield of acidic oxides of nitrogen is obtained in the radiolysis of dry air. When samples of air contained in silica ampoules at pressures between 6 and 75 atm at 227°C were given radiation doses in the range 2 to 100 Mrad a marked dependence of the yield on dose was observed. Thus, at 30 atm (227°C) the yield per 100 ev decreased from 3.0 at 2×10^6 rad to 0.8 at 1×10^8 rad under gamma and pile (n + γ) irradiation. The production of acidic oxides was also found to vary with pressure, exhibiting a maximum between 30 and 40 atm. At a dose of 1×10^8 rad the yield of the desired products was independent of temperature over the range 150 to 500°C. No significant variation in G (acidic oxides) with radiation intensity was detected when samples of air at 26 atm (200°C) were given fission-fragment doses of 6×10^8 rad at rates varying from 176 to 942 Mrad/hr. (auth)

13897 SOME COMMENTS ON CHEMISTRY RESEARCH AND CHEMICAL TECHNIQUES BASED ON RESEARCH REACTORS. R. Hara (International Atomic Energy Agency, Vienna). p.361-71 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Chemical research using research reactors is discussed. Both fundamental and applied research are considered, including studies of chemical properties of radionuclides, production of radioisotopes, preparation of labeled compounds, applications of Szilard-Chalmers reactions, activation analysis, and technological investigations. (M.C.G.)

13898 THE RESEARCH PROGRAM IN RADIOCHEMISTRY AND RADIATION CHEMISTRY USING THE NUCLEAR REACTOR AT THE NATIONAL TSING HUA UNIVERSITY. Si Jung Yeh (National Tsing Hua Univ., Taiwan, China). p.395-402 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Operation of the National Tsing Hua University Swimming Pool Reactor is described. Research activities in activation analysis, process studies for production of short-lived isotopes, hot-atom chemistry, and radiation chemistry are discussed. (M.C.G.)

13899 RECENT DEVELOPMENTS IN THE THEORY OF MECHANISMS IN RADIATION CHEMICAL PROCESSES. R. Roberts (United Kingdom Atomic Energy Authority, Wantage, Berks, Eng.). p.3-13 of "Industrial Uses of Large Radiation Sources. Vol. I." Vienna, International Atomic Energy Agency, 1963.

Studies of the mechanisms of radiation-initiated chemical reactions are reviewed. The role of ion molecule processes is reviewed, with particular reference to the radiation chemistry of methane. In this system, the existence of reactions of excited molecules, in addition to ionic processes, was deduced. It is shown that, in the radiolysis of methane, unsaturated hydrocarbons play a considerable part in the mechanism of reaction. Developments in ionic polymerization and also polymerization under heterogenous conditions are reviewed. The importance of reactant purity, and also cleanliness of reaction vessels is discussed. The effect of an applied external potential in solid state polymerization is briefly reviewed. The importance of free-radical processes to radiation chemists is considered in the light of the Dow process for the production of ethyl bromide. (auth)

13900 COPOLYMERIZATION OF ETHYLENE INDUCED BY COBALT-60 GAMMA RADIATION. M. Steinberg and P. Colombo (Brookhaven National Lab., Upton, N. Y.). p.121-50 of "Industrial Uses of Large Radiation Sources. Vol. I." Vienna, International Atomic Energy Agency, 1963.

The gamma-initiated copolymerization of ethylene with a number of different monomers was studied at 20°C and initial pressures up to 680 atm. The experiments were conducted statically in two-phase systems with the exception of the ethylene-carbon monoxide system. Isolation of the copolymers was effected by solvent extraction and fractional precipitation techniques. Infrared spectroscopy was used for identification. The composition was deter-

mined by elemental analysis. A partial evaluation of some of the reaction products including crystalline melting points, densities, solubility characteristics, and molecular weights is given. Evidence of ethylene copolymerization was established with each of the following monomers: styrene, methyl methacrylate, vinyl acetate, acrylonitrile, allyl acetate, isobutylene, chlorotrifluoroethylene, trans-2-butene, methyl acrylate, isoprene, propylene, vinyl chloride, 1-butene, cis 2-butene, carbon monoxide, vinyl pyrrolidone, methyl vinyl ketone, and divinyl benzene. The experimental data obtained in the study of the ethylene-carbon monoxide system were found to obey a linear form of the copolymer composition equation. The ratio of specific rate constants for carbon monoxide and ethylene (α) was found to have a value of 22.0, indicating that carbon monoxide as a monomer, is activated to the extent that it adds 22 times as fast as an ethylene monomer to an ethylene free-radical chain end. Explosive decomposition was observed to occur during irradiation of ethylene and chlorotrifluoroethylene under certain irradiation conditions. There is an indication that a threshold radiation intensity exists which induces this violent reaction. The advantage of Co^{60} gamma radiation is that it can be used to induce and control ethylene copolymerization reactions at low temperatures. (auth)

13901 RADIATION-INDUCED POLYMERIZATION OF ALDEHYDES AND KETONES. K. Hayashi, H. Yamaoka, K. Fujiwara, M. Sakamoto, S. Mori, T. Natori, H. Yoshida, and S. Okamura (Japanese Assn. for Radiation Research on Polymers, Osaka and Kyoto Univ.). p.219-32 of "Industrial Uses of Large Radiation Sources. Vol. I." Vienna, International Atomic Energy Agency, 1963.

Several kinds of aldehydes and ketones are polymerized by irradiation. Formaldehyde can be polymerized into high molecular weight polyoxymethylene by radioinduced polymerization in the liquid phase at low temperatures. The polymerization mechanism is considered to be a cationic chain reaction both in the case of bulk and of solution in methylenechloride and toluene, but to be anionic in ethyl ether. Acetaldehyde and propionaldehyde are recognized as being hardly polymerized in the pure liquid phase, but easily polymerized in the presence of γ-alumina. In the solid state polymerization, crystalline polymers are obtained as the stable-for-heat-treatment form under suitable conditions. Glyoxal can be polymerized into a three-dimensional network polymer. With formaldehyde it can be copolymerized into cross-linked polyoxymethylene. Acetones such as chloro or bromoacetone and methylethylketone or diacetyl can be polymerized in the solid state into polymers which are unstable. Ketene can be polymerized into a polyester-type polymer with liquid phase polymerization; polyketone is obtained additionally when polymerization is carried out in the solid state. The copolymer with formaldehyde is slightly more stable. Dimethylketene can be easily polymerized both in the liquid and solid states into polyacetal. All these polymerizations are special examples of radioinduced reactions. (auth)

13902 GRAFT POLYMERIZATION OF STYRENE TO POLYETHYLENE. J. Silverman, S. I. Srinivasan, and C. J. Phalangas (Univ. of Maryland, College Park). p.245-56 of "Industrial Uses of Large Radiation Sources. Vol. I." Vienna, International Atomic Energy Agency, 1963.

Study of published data on radioinduced grafting of styrene to low density polyethylene films showed that the rate of weight gain has only a small dependence upon the gamma exposure rate and film thickness. It was demonstrated that the models used by previous investigators to interpret weight-gain data for evaluation of rate constants are not applicable. Data are presented for grafting experiments at 18 and 40°C using polyethylene films and fluff and Co^{60} gamma exposure rates up to 8.0×10^5 r/hr. The rate of conversion of styrene to homopolymer in the fluff suspensions was also measured. Microscopic examinations were performed on the grafted film to estimate the amount of occluded homopolymer. The results demonstrated that most of the weight gain in film samples is due to occluded homopolymer. In the fluff experiments, in which the weight gain was largely due to graft copolymer, the weight increase was approximately linear with dose and the reaction rate was almost proportional to the square root of the gamma exposure rate. A low activation energy for the reaction rate precluded the possibility of diffusion control in fluff and in thin films at exposure rates below 10^3 r/hr. The rate of homopolymer formation in the fluff experiments performed at 18°C and 7.2×10^4 r/hr was the same as that reported for polymer formation in pure styrene. The activation energy, 3.5 kcal/mol, was almost half the value reported for the pure monomer. (auth)

13903 SOME POSSIBILITIES OF RADIATION POLYMERIZATION FROM THE GASEOUS PHASE ON SOLID BASES. B. L. Tsetlin. p.289-300 of "Industrial Uses of Large Radiation Sources. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In Russian)

The unusual feature of graft polymer synthesis by solid "bed" irradiation in the presence of monomer vapors is that the activation centers initiating polymerization are in practice generated only on the bed; transmission of the kinetic chain to the monomer is impeded and new polymer chains grow only under the influence of the solid bed molecular forces. These features of gas-phase processes enlarge the scope of the graft-polymer technique, making it applicable to inorganic beds and usable in the synthesis of mineral organic products. If stretched synthetic fibers are used as a bed, on the other hand, their orientated macromolecules control the growth of new polymer chains and the graft polymer is formed directly as an orientated structure. Two-component combined fibers are formed as a result and the fiber-bed and "grafted" fiber may in appropriate circumstances each display their own particular complex of mechanical properties. (auth)

13904 GRAFTING TO POLYMETHYLMETHACRYLATE BY THE RADIATION-PEROXIDATION METHOD. J. F. Kircher, R. A. Markle, R. Lieberman, F. A. Sleimers, and R. I. Leininger (Battelle Memorial Inst., Columbus, Ohio). p.319-28 of "Industrial Uses of Large Radiation Sources. Vol. I." Vienna, International Atomic Energy Agency, 1963.

Studies of the radiation-peroxidation of polymethylmethacrylate (PMMA) are discussed in relation to the subsequent grafting of vinyl pyrrolidone to the peroxidized polymer. The peroxidation was investigated as a function of dose, PMMA molecular weight, and irradiation temperature. It is shown that low molecular weight PMMA is more effectively peroxidized and grafted at doses of a few megarads than a relatively high molecular weight polymer. It was also observed that increasing the temperature to about the glass transition also increases peroxidation and grafting. The results are explained in terms to the effects of temperature and molecular weight on the mobility of polymer and fragment radicals. (auth)

13905 EFFECT OF GAMMA IRRADIATION ON NATURAL AND SYNTHETIC LATEXES. V. L. Karlov, D. M. Sandomirskii, V. G. Yurkevich, and N. M. Sergeev. p.363-

76 of "Industrial Uses of Large Radiation Sources. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In Russian)

As compared with bulk rubber, rubber particles in latexes vulcanized by irradiation possess specific properties. The properties of synthetic latex particles (SKS-30A and SKN-40) vulcanized by gamma irradiation, and of the films obtained from them, differ in properties they acquire by other vulcanization techniques. Changes in the properties of latex (pH-value, surface tension, viscosity, etc.) as a colloidal system under irradiation depend to a considerable extent upon the chemical nature of the rubber and on its derivation. Yields differ according to whether the vulcanization is carried out by particle or by bulk irradiation. Aging processes for such latexes and the films obtained from them differ from aging processes for non-vulcanized or sulfur-vulcanized latexes. The radiation-vulcanized products have increased stability. The properties of the vulcanized rubber in the latex are confirmed by data indicating high-resolution nuclear magnetic resonance spectra. (auth)

13906 MANUFACTURE OF WOOD-PLASTIC COMBINATIONS BY USE OF GAMMA RADIATION. J. A. Kent, A. Winston, W. Boyle, and L. Updyke (West Virginia Univ., Morgantown). p.377-404 of "Industrial Uses of Large Radiation Sources. Vol. I." Vienna, International Atomic Energy Agency, 1963.

A commercially feasible process for producing wood-plastic "alloys" by the use of gamma radiation is described. The process is separable into two parts: impregnation of the selected wood with the desired monomer; and in situ polymerization of the monomer by the use of gamma radiation. The variables affecting penetration of monomer into the wood structure were studied and tests disclosed that good distribution of polymer in the resultant product is possible under practical conditions. Specimens up to four inches thick and five feet long were impregnated and examined for monomer penetration and others of similar thickness were successfully carried through the polymerization step. Soft woods behave much differently from the hardwoods insofar as their penetrability to monomer is concerned. It is possible, within limits, to control the uptake of monomer to give desired polymer concentrations in various wood species. Conversion curves are presented for the radiation polymerization of methylmethacrylate, vinyl acetate, and styrene in white pine, white oak, red oak, poplar, birch, beech, spruce, and hard maple. The effect of dose rate on polymerization rates is shown. Several systems are incompatible. For example, redwood does not support the polymerization of vinyl acetate or methylmethacrylate while white pine does not permit the polymerization of vinyl acetate. Cross-linking agents are under examination to determine their effectiveness in increasing the polymerization rate so that shorter cycle times might be achieved. Test results are presented for allyl acrylate, ethylene glycol dimethacrylate, polyethylene glycol dimethacrylate, tetraisopropyltitanate, allyl methacrylate, and (in the case of styrene) divinyl benzene. Physical tests performed on wood-polymer systems show that hardness, elastic limit in compression, dimensional stability, and certain other properties are enhanced. There is in general an increase in brittleness over the unmodified wood. Data are presented for hardness, elastic limit in compression, dimensional stability, static bending, and shear. (auth)

13907 RADIOLYSIS AND PROPERTIES OF SANTOWAX OMP AT ELEVATED TEMPERATURES. C. D. Sawyer, E. A. Mason, and W. N. Bley (Massachusetts Inst. of Tech., Cambridge, Mass.). 6p. (CONF-187-107)

From American Nuclear Society Meeting, New York, Nov. 1963.

The effects of radiation on Santowax OMP were studied at irradiation temperatures of 610 and 750°F. Samples of the irradiated coolant were analyzed for: ortho-, meta-, and para-terphenyl concentrations by gas chromatography; high boiler concentration by distillation; low and intermediate boiler concentration by difference; viscosity; density; and specific heat and thermal conductivity. At 750°F the isomer stability was found to be para > meta > ortho. At 610°F the radiolytic gas generation rate was 0.037 ± 0.006 molecules of gas generated per 100 ev absorbed in the coolant mixture. During the 750°F irradiation radiolytic gas was generated at about three times this rate. Data are tabulated. (P.C.H.)

13908 RADIOLYSIS OF POLYISOBUTENE. PART 4. A STUDY OF THE ROLE OF FREE RADICALS IN THE FRACTURE REACTION USING RADIOACTIVE ADDITIVES. G. Ayrey (London Univ.) and D. T. Turner. 24p. (CONF-415-1)

From American Chemical Society 15th Annual Southeastern Regional Meeting, Charlotte, N. C., Nov. 1963.

The influence of additives on the formation of polymer radicals and macromolecular fractures in polyisobutene by exposure to 4 Mev electrons was studied using phenyl-H^3-sec-butyl-S_1^{35}-disulfide, thiophenol-H^3, thiophenol-S^{35}, and nitrobenzene-C^{14}. G(polymer radicals) was found to decrease from a maximum value of 7.3 at a concentration of thiophenol of $3\text{-}5 \times 10^{-4}$ moles/g to 4.5-5.4 at about 15×10^{-4} moles/g and then to remain constant. It is supposed that the primary polymer radicals are formed by processes that are relatively insensitive to the presence of large concentrations of a protective agent. Comparison of the effects of thiophenol on yields of radicals and fractures led to the conclusion that two types of primary polymer radical are formed. One is due to the fracture of C–H and C–CH_3 bonds, $4.2 \geq G(\text{—}) \geq 2.7$, and the other to direct fracture of the main chain of carbon atoms, $G(\text{—}\cdot) \geq 3.1$. At its maximum, low solubility in the polymer nitrobenzene-C^{14} increases G(fractures) by 0.6 and 0.7 and G(nitrobenzene combined with polymer) = 1.2 and 1.0 after doses of 5 and 10 Mrad, respectively. An explanation is suggested for the contrasting effects of thiophenol and nitrobenzene at low concentrations. (P.C.H.)

Separation Processes and Procedures

Refer also to abstract 15511.

13909 (DP-850) OPERATING AND DESIGN VARIABLES OF AGITATED ION EXCHANGE BEDS. Milton W. Davis, Jr., Merle R. Klingler, and James F. Ward, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Oct. 1963. Contract AT(07-2)-1. 22p.

Large- and small-scale agitated ion exchange beds, containing one and three stages of 20 to 50 mesh "Dowex" 1-X4 anion resin, performed satisfactorily with solutions containing 300 to 800 ppm of gelatinous solids which could not be removed by a simple step of feed clarification. Operating and design variables of the bed were investigated by measuring the absorption efficiency for $Th(NO_3)_6^{2-}$. (auth)

13910 (HW-56675(Del.)) PROCESSES AND TECHNIQUE FOR THE RECOVERY OF NEPTUNIUM-237 FROM

A PUREX-TYPE SOLVENT EXTRACTION PLANT PROCESSING IRRADIATED URANIUM FUEL ELEMENTS. W. H. Swift and S. J. Beard (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 9, 1958. Contract AT(45-1)-1350. 7p.

A technique is outlined for removing accumulated Np^{237} from the aqueous raffinate in the Purex Process. The technique comprises processing the solutions prior to plant shutdown to accumulate essentially all of the Np^{237} in the waste backcycle, adjusting the chemical composition of this feed material, and processing the feed to achieve purification, decontamination, and concentration of the Np^{237} into a small volume of nitrate solution. Chemical flowsheets are given. (D.L.C.)

13911 (HW-78892) PYROCHEMICAL SEPARATION OF CERIUM-RARE EARTH FISSION PRODUCTS. J. T. Knight (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 13, 1963. Contract AT(45-1)-1350. 17p.

A study was made of the potential of the nitrate salt thermal decomposition process for cerium separation and cerium oxide preparation. In this process, magnesium nitrate fluxing agent is used to form insoluble cerium oxide which is then separated from the rare earth nitrates by filtration. The results of the study show that the process is possible, although the product purity is low. For a reaction of 1 hr at 260°C, 94% of the cerium was recovered as CeO_2 of 77% purity, and the effects of higher and lower temperature on the purity were studied. (D.L.C.)

13912 (HW-SA-2928) NEW NEPTUNIUM RECOVERY FACILITY AT THE HANFORD PUREX PLANT. J. P. Duckworth and L. R. Michels (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 1, 1963. Contract AT(45-1)-1350. 22p. (CONF-427-1)

From American Chemical Society 146th National Meeting, Denver, Jan. 1964.

An additional solvent extraction battery was installed in the Purex Plant for the continuous recovery of Np^{237} from irradiated reactor fuels. A description is given of the recovery equipment. (D.L.C.)

13913 (HW-SA-3283) NEPTUNIUM RECOVERY AND PURIFICATION AT HANFORD. R. E. Isaacson and B. F. Judson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 10, 1963. Contract AT(45-1)-1350. 26p. (CONF-322-3)

From American Chemical Society Production Technology of Np-237 and Pu-238, Denver, Jan. 1964.

Neptunium is routinely recovered from irradiated fuel elements at Hanford's two main separation plants. Initial development tests were started in the Purex plant in 1958, then in the Redox plant in 1959, and recently culminated in the installation of new production systems in both plants for improved recoveries. Both recovery flowsheets employ solvent extraction techniques based on the relative extractability of neptunium-VI. The neptunium is co-extracted with uranium and plutonium in the plants' first extraction cycles and then partitioned and decontaminated in separate neptunium cycles. Excellent decontamination from fission products is achieved without interfering with mainline uranium and plutonium production. Recovered neptunium is purified by anion exchange and shipped offsite for subsequent irradiation to plutonium-238. Overall separation factors of uranium and fission products from neptunium are greater than 10^7 and 10^{10} respectively. (auth)

13914 (HW-SA-3377) ENGINEERING STUDIES. FISSION PRODUCT PLANTS AT HANFORD. C. Wesley Smith (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 25, 1964. Contract AT(45-1)-1350. 41p.

Engineering studies were made of a high-capacity, integrated fission product purification and encapsulation facility, and capital, operating, and unit cost estimates were prepared for the plant. The design criteria on which the studies are based are given. The process and facilities are described. The studies are based on two alternate Waste Mangement Flowsheets and on facilities which are either entirely separate from or attached to the 221-B building. (D.L.C.)

13915 (IS-728) AN INFRARED STUDY OF THE TRIBUTYL PHOSPHATE–NITRIC ACID–WATER SOLVENT EXTRACTION SYSTEM. Patrick John Kinney and Morton Smutz (Ames Lab., Ames, Iowa). Aug. 1963. Contract W-7405-eng-82. 163p.

The results of a detailed infrared study on the systems TBP (tributyl phosphate), HNO_3, TBP–HNO_3, TBP–HNO_3–CCl_4, and TBP–HNO_3–H_2O coupled with phase distribution data are interpreted in terms of the molecular interactions taking place in the solutions. A mechanism was established for the extraction of nitric acid from an aqueous solution by TBP: A strong TBP·HNO_3 complex forms by hydrogen bonding at the P = O site of the TBP replacing the more weakly held water of a TBP·H_2O complex and causing the water content of the organic phase to decrease. Past a 1/1 HNO_3/TBP mole ratio in the organic phase, additional nitric acid is present in the solution through a mechanism of "solubility" of nitric acid in the strong TBP·HNO_3 complex. This solubility includes contributions from free HNO_3 as well as contributions from hydrogen bonding interactions between the additional acid and the TBP·HNO_3 complex, most probably involving the P–O–C linkage. However, no definite stoichiometries could be assigned from the spectral results. The water content of the organic phase, after going through a broad, non-zero minimum, begins to rise again due to a secondary mechanism of solubility. (auth)

13916 (ORNL-3558) TRANSURANIUM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING AUGUST 31, 1963. W. D. Burch, comp. (Oak Ridge National Lab., Tenn.). Mar. 1964. Contract W-7405-eng-26. 123p.

The development of processes to separate and purify the transuranium elements, process equipment development, HFIR target fabrication studies, design of the TRU Processing Plant, design and installation of development facilities, corrosion studies, and analytical research directed toward this program are reported in 6 papers. Separate abstracts were prepared for each paper. (M.C.G.)

For abstracts of individual papers see: 13638, 13917, 13918, 13919, 14410, and 14426.

13917 (ORNL-3558(p.7-55)) DEVELOPMENT OF CHEMICAL FLOWSHEETS FOR THE OVERALL PROCESS. K. B. Brown and R. E. Leuze (Oak Ridge National Lab., Tenn.).

A series of five countercurrent solvent extraction tests were made of the Tramex flowsheet with Cm^{242} power densities varying from 5 to 10 w/liter. No adverse effect on the extraction process was noted due to alpha radiation, and the results indicated that the Tramex process can achieve both high recovery of transplutonium elements and high decontamination from fission products. The principal effect of alpha radiation in Tramex feed was a loss of acid at the rate of about 0.1 mole per liter per day at activity levels of 10 w/liter. Since Tramex process separations are greatly affected by small changes in acidity, methods for controlling this acid loss were studied. Reducing agents such as

formaldehyde and methanol were effective in preventing acid loss. Ten volume percent methanol in 10M LiCl containing 18 w of Cm^{242} per liter maintained the acid concentration between 0.03 to 0.06M for 25 days. Additional studies are in progress to determine the effect of methanol on the Tramex extraction process. Equilibration of Tramex feed with inert gas containing a reduced partial pressure of hydrogen chloride was also investigated as a method for controlling feed acidity. Results indicated that feed acid could be maintained in the desired range when the feed temperature was elevated to 120°C, but difficulties attendant with maintaining feed at this temperature made this method of acid control unattractive. The addition of small amounts of Alamine 336 · HNO_3 to Alamine 336 · HCl–DEB was investigated as a possible means of increasing actinide distribution coefficients. It was hoped that with higher distribution coefficients, the control of Tramex feed acid would be less critical. However, the extraction in the chloride–nitrate system was even more sensitive to free acid than in the all-chloride system. Laboratory demonstrations of the conversion of Cm^{242} product solutions from chlorides to nitrates by adding nitric acid to remove the chloride were made in 1/10-scale tantalum equipment with simulated feed. Effective chloride removal was obtained; however, the nitric acid concentration of the final product was about 15M. Ruthenium did not volatilize during the conversion, but volatile RuO_4 was formed when small quantities of $NaBiO_3$ were added to the boiling 15M HNO_3. The use of spring-loaded ion exchange columns improved column operation during Am^{241}–Cm^{242} separations at activity levels of 50 w/liter. The effect of gassing was thereby controlled, and separation of the resin bed was prevented. Lithium chloride anion exchange was successfully used to recover and purify americium–curium containing 22 mg of Cm^{242} and to separate gram quantities of Am^{241} from contaminant rare earths. These products are being used in current development work. Seventy-nine grams of high-fired PuO_2 in the desired particle size range (–70 to +325 mesh) was prepared for use in prototype HFIR targets. Several methods of preparation were investigated. Methods to recover plutonium from HFIR target rejects were also investigated. A method developed for the separation of the lanthanides from the trivalent actinides gives separation factors of about 100 between the least extractable lanthanide and americium. It consists of extracting the lanthanides by a monoacidic organophosphate or phosphonate in an aromatic diluent from a mixed solution of a carboxylic acid and an aminopolyacetic acid complexing agent. A suitable extractant is a diisopropylbenzene solution of di(2-ethylhexyl)-phosphoric acid, and a suitable aqueous phase is 1M lactic acid containing 0.1M pentasodium diethylenetriaminepentaacetate, the complexer for the trivalent actinides. The trivalent actinides may be recovered subsequently from the aqueous phase by oxalate precipitation or by extraction with a stronger extractant such as an n-dodecane solution of 2-ethylhexylphenylphosphonic acid, followed by stripping with nitric acid. Neither nitrate salts nor any reasonable amount of radiation absorption interferes with the separation. The higher extractability of californium and the heavier actinides makes their separation from the lanthanides considerably more difficult than the separation of americium and curium from the lanthanides. Tracer level Am(VI) was usually less extractable than Am(III) in several extraction systems. Extraction by di(2-ethylhexyl)phosphoric acid from dilute nitric acid showed a preference of 10^4 for Am(III) and indicated a possible method for preferential extraction of Cm(III) from Am(VI). (auth)

13918 (ORNL-3558(p.55-61)) EXPERIMENTAL ENGINEERING STUDIES. P. A. Haas, A. D. Ryon, and C. D. Watson (Oak Ridge National Lab., Tenn.).

The design concepts and process equipment important to the processing facility are being tested in a full-scale cell mockup. Tests of procedures for replacing the equipment, which depend on use of disconnects, equipment racks, and an equipment transfer case, were continued. An improved cell lighting system was developed. Procedures for replacing manipulator booting and "alpha" windows were tested. The system and procedure for removing and replacing resin in an ion exchange column was demonstrated. Pulsed columns were tested for the scrubbing of europium tracer from 30% Alamine 336. The average stage height of 17 in. and total throughout of 12 ml/min at 50°C, 40-cpm frequency, and 0.2-in. amplitude were not appreciably improved for other conditions tested. All tests were performed in 3/4-in. glass columns equipped with tantalum plates (5% free area) on 1/4-in. spacing. Four of 54 protective coatings tested at a dose of 4×10^9 r of gamma radiation were still serviceable after exposure in deionized water, and 29 after exposure in air. Decontamination factors by a simple water flush and a 3M HNO_3 scrub averaged 1850 for polyesters, 990 for vinyls, 870 for epoxies, and 410 for modified phenolics. (auth)

13919 (ORNL-3558(p.83-104)) TRANSURANIUM PROCESSING PLANT DESIGN. W. E. Unger (Oak Ridge National Lab., Tenn.).

Installation of equipment in the "hot" development facility, cell 4 of Building 4507, was almost completed, and cold startup operations were begun. Design of the supporting equipment in cell 3, including a dissolver and work space for laboratory-type equipment is proceeding. A carrier-unloading station, which will permit the transfer as a nitrate solution of the americium–curium-rare earth fraction from the Savannah River TRU irradiations into an underground storage tank outside Building 4507 was designed, built, and installed. Design of the chemical process equipment for the facility is about 33% complete. Sixteen engineering flowsheets and 47 equipment drawings were approved and issued. Major equipment items for which design was completed are: the process samplers, the dissolvers, cubicle-to-pit disconnect well and line-bundle structure, and the first-cycle solvent extraction equipment rack. The intercell piping concept, including remotely replaceable Zircaloy-2 waste and off-gas headers, was completed and detail design started. Design modifications to the disconnect clamp were made in order to provide a positive opening and closing action and to facilitate remote removal and replacement of the top clamp and bolt assembly. Installation of underground piping was well advanced, and excavation for the cell bank was completed. Procurement by ORNL of critical items for installation by the building contractor, and the design and fabrication of mechanical equipment for the building is proceeding on schedule. A complete re-evaluation of the ORNL design Critical Path Schedule and manpower requirements was made in July, including redrawing of all arrow diagrams. A significant increase in estimated design manpower resulted, but no change was made in the overall schedule. (auth)

13920 (TID-7677(p.163-76)) ANALYSIS OF A POSSIBLE INFLUENCE OF PARTICLE SIZE ON THE IODINE REMOVAL EFFICIENCY OF A CHARCOAL FILTER. L. A. Haack (Oak Ridge National Lab., Tenn.).

It is shown that to describe properly the efficiency of a filter in removing contaminants, especially I^{131}, from an air stream not only must the amount of impurities be specified but also that the size distribution of particles in

the air stream must be specified. Calculations and comparisons are presented. (M.C.G.)

13921 CONTRIBUTION TO STUDIES ON THE CRYSTALLIZATION OF CESIUM WITH ALUM. B. López Pérez and S. J. Rimshaw. Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 59: 681-6(Nov. 1963). (In Spanish)

The alums act as an excellent carrier for the cesium due to the relative insolubility of the cesium aluminum alum. The crystallization of cesium with alums was applied to separate cesium from the long-lived radioactivities found in fission-product wastes. This work was carried out to determine the type of law that describes the process and the values of the distribution coefficients. (auth)

13922 STUDIES OF THE SYNTHETIC INORGANIC ION EXCHANGER. III. THE SEPARATION OF THE FISSION PRODUCT BY MEANS OF A STANNIC PHOSPHATE CATION EXCHANGER. Yasushi Inoue (Tohoku Univ., Sendai). Bull. Chem. Soc. Japan, 36: 1324-31(Oct. 1963).

The mutual separation of various nuclides contained in fission product was carried out with a stannic phosphate cation exchanger. Various concentrations of nitric acid and ammonium chloride solutions were used as eluants, and the separation was performed on hydrogen- and ammonium-form exchangers. The separations of $Sr^{89}-Cs^{137}$, $Sr^{89}-Ce^{144}$, $Cs^{137}-Ce^{144}$ and $Sr^{90}-Y^{90}$ were easy and complete except for that of $Cs^{137}-Ce^{144}$ on a hydrogen-form exchanger. Zr^{95} and Nb^{95} were almost completely adsorbed on the exchanger over a wide range of acidity and salt concentration; therefore, they were not eluted at all. As the behavior of Ru^{106} is complex and its separation from other nuclides is impossible, it is necessary to separate the ruthenium from the fission product in advance by a method other than that of ion exchange. With reference to the results, the total analysis of the fission product on an ammonium-form exchanger was carried out. It is almost complete except for the contamination of rare earth in the cesium fraction. (auth)

13923 IMPROVEMENT OF THE EXTRACTION SEPARATION OF URANIUM AND ZIRCONIUM USING ZIRCONIUM-MASKING REAGENTS. M. Kyrs, R. Caletka, and P. Selucky (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 28: 3337-44(Dec. 1963). (In German)

The masking capacities of a series of reagents were studied in the zirconium extraction with tributyl phosphate solution in the presence of nitric acid. It was established that with many reagents an improvement of the separation of uranium from zirconium could be obtained. The efficiency of the reagents increases in the series tannin, oxalic acid, tiron, pyrogallol, and Arsenazo I. (tr-auth)

13924 RAPID SEPARATION OF RARE EARTHS AND TRANSPLUTONIUM ELEMENTS ON ION EXCHANGERS. H. Beranová and V. Petrzila (Inst. for Nuclear Research, Dubna, USSR). Collection Czech. Chem. Commun., 29: 500-15(Feb. 1964). (In German)

The influence of flow-through velocity of ammonium lactate as elution reagent, the particle size of the ion exchanger, and the manner of initial sorption of $Eu^{152}-Am^{241}$ mixtures on their separation and the width of their elution curve at room temperature was investigated. For the separation of a mixture of several elements and for determination of the separation factor Y^{91}, Pm^{147}, and Cm^{242} were used. The separation of the $Eu^{152}-Am^{241}$ mixture was characterized by the values P, and P_2, which specify the mutual percentage contamination of the maxima of the elution curve. This method of rapid separation was investigated for the separation of several elements and a $Cf^{248}-Fm^{252}$ mixture that were obtained by irradiating U^{238} with Ne^{22} ions. (tr-auth)

13925 FACTORS AFFECTING THE REMOVAL OF RADIOSTRONTIUM FROM MILK BY ION-EXCHANGE RESINS. D. G. Easterly, J. Y. Harris, L. A. Bunce, and L. F. Edmondson (Dept. of Agriculture, Washington, D. C.). J. Dairy Sci., 46: 1207-10(Nov. 1963).

Experiments were designed to determine the effect of temperature, direction of milk flow, milk flow rate, and quantity of milk passed through an ion-exchange column, on the removal of Sr from milk. Daily milk samples from a cow fed 0.5 mC Sr^{85} (nitrate) were passed through a column 1.5-in. in dia containing 100 ml of Amberlite IR-120 resin. The resin used was regenerated by passing 25 ml of charging solution per ml resin, containing 625, 83, 217, and 385 meq of Ca, Mg, Na, and K, respectively. This is ~10 times the concentration of these ions in normal milk. Milk temperature in the range 40 to 80°F did not affect the amount removed (about 85%) when the milk was acidified to a pH of 5.4. When milk was passed through at normal pH (6.65), about 8% more removal was obtained at 100 than at 40°F. No further increase was obtained by heating the milk to 180°F. However, less than half of the Sr was removed from nonacidified milk regardless of temperature. The temperature studies were carried out at a flow rate of 0.5 resin bed volume (rbv)/min. The amount removed from the first 30 rbv decreased from 96 to 71% as the flow rate was increased from 0.125 to 2.00 rbv/min. Studies comparing the relative effectiveness of downflow and upflow of milk through the columns showed that about 8% more Sr was removed by downflow at a flow rate of 0.25 rbv/min and 12% more at 1.0 rbv/min, than by upflow. This could be due to the turbulent action of the milk on the resin when the upflow procedure is employed, causing it to act more like a batch procedure. Under these conditions, the chromatographic effect of the column is lost. Results of these flow rate studies are in agreement with previous work which showed that milk-resin contact time had a significant effect on the removal of Sr and Ca from milk. (BBB)

13926 BEHAVIOR OF PLUTONIUM IN THE PHOSPHORIC ACID-TRIFLUOROACETIC ACID SYSTEM. J. M. Cleveland (General Electric Co., Richland, Wash.). J. Inorg. Nucl. Chem., 26: 461-7(Mar. 1964).

Plutonium (III) and (IV) are efficiently extracted from concentrated trifluoroacetic acid solution into 85% phosphoric acid. Extraction of plutonium(III), followed by further contacting with the trifluoroacetic acid phase, results in rapid conversion of the plutonium to the tetravalent state, the trifluoroacetic acid acting as a catalyst for the air oxidation. The same phosphate complex results from the extraction-oxidation of plutonium(III) and the extraction of plutonium(IV), and it does not contain trifluoroacetic groups. Plutonium(IV) trifluoroacetic, $Pu(CF_3COO)_4 \cdot xH_2O$ was prepared as a precipitate by allowing a trifluoroacetic acid solution of plutonium(III) to air oxidize. (auth)

13927 THE EXTRACTION OF RARE EARTH NITRATES WITH TRI-n-BUTYL PHOSPHATE (TBP). F. V. Robinson and N. E. Topp (National Chemical Lab., Teddington, Middx., Eng.). J. Inorg. Nucl. Chem., 26: 473-6(Mar. 1964).

Equilibrium data on rare earth nitrates in tri-n-butyl phosphate are given. The results are consistent with the formation of a trisolvate, $Ln(NO_3)_3 \cdot 3TBP$, in the organic phase. It was confirmed that the separation factors in-

crease with saturation of the organic phase. The partition coefficients of trace concentrations of rare earths, in the presence of macroscopic quantities of other earths, showed a maximum at Ho when the organic phase approached saturation. (P.C.H.)

13928 RHENIUM RECOVERY BY SOLVENT EXTRACTION AND ELECTRODEPOSITION. P. E. Churchwood and J. B. Rosenbaum. J. Metals, 15: 648-50(Sept. 1963).

Description is given of a procedure for recovering Re in the form of electrolytic flakes by electronwinning the metal from a solvent extraction strip solution. The recovered Re contains about 0.1% Mo and spectrographic traces of other impurities. The uses and properties of Re are included and conventional recovery methods reviewed. (Rev. Metal Lit., 21: No. 1, Jan. 1964)

13929 A NEW INDUSTRIAL SCALE CARRIER-FREE $H_2S^{35}O_4$ PRODUCTION METHOD. R. Plejewski and M. Kucharski (Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw). Kernenergie, 7: 38-40(Jan. 1964). (In German)

A method for preparation of $H_2S^{35}O_4$ from reactor-irradiated potassium chloride is described. For separation of the S^{35} from the irradiated target, two chromatographic columns were used. The first was loaded with Al_2O_3 and served for the separation of sulfur from P^{32}, Cl^{36}, Cl^{38}, K^{42}, and the principal amount of KCl. The second was loaded with a cation exchanger in H-form, served for separation of the sulfur from all cationic impurities (among them the remainder of K^+), and guaranteed that the sulfur is present as sulfuric acid. The parameters of the column were so chosen that the two columns are sufficient for a single run and that the radioactive end products with high specific activity were retained, so that they were no longer suited for use. (tr-auth)

13930 INVESTIGATION CONCERNING THE CHELATING EXTRACTION OF Sr 90 FROM WATER BY 2-THENOYLTRIFLUORACETONE. K. D. Beccu (Hydrologischen Forschungsabteilung der Dortmunder Stadtwerke AG, Dortmund, Ger.). Kerntechnik, 6: 5-8(Jan. 1964). (In German)

Chelating extraction using 2-thenoyltrifluoracetone in a mixture of organic solvents is suitable for determination of even very small Sr^{90} concentrations in water. A working scheme consisting of seven extraction steps carried out under different P_H conditions permits the separation of Sr^{90} from other radionuclides and the largest part of inactive salts. The radiochemical purity of the separated active Sr^{2+} fraction is checked by a procedure of ion-focusing. The concentration limit of Sr^{90} is below 1 pC/l, the error amounts to 10%. (auth)

13931 THE RECOVERY OF PROTACTINIUM AND URANIUM FROM MOLTEN FLUORIDE SYSTEMS BY PRECIPITATION AS OXIDES. J. H. Shaffer, W. R. Grimes, G. M. Watson, D. R. Cuneo, J. E. Strain, and M. J. Kelly (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 18: 177-81(Feb. 1964).

In the conceptual two-region molten-salt breeder reactor, fissionable U^{233} is recovered from the blanket as the decay product of Pa^{233}. Since equilibrium concentrations of Pa^{233} would result in appreciable parasitic neutron absorptions, the advantages of thermal breeding could be realized to a greater extent by removing both Pa^{233} and U^{233} from the blanket mixture. Methods for recovering these materials from molten-fluoride mixtures by precipitation as oxides are presented. Small-scale experiments clearly indicated that it is possible to remove protactinium from molten-fluoride solutions by a process that appears to be surface precipitation of protactinium on beryllium oxide or thorium oxide particles. Protactinium was removed from molten mixtures of $LiF-BeF_2-ThF_4$ (67-18-15 mole %) by the addition of 1 to 2% by weight of solid beryllium oxide or thorium oxide. The removal efficiency was high when the initial concentration of protactinium was either in the range 1 to 2 ppb or 50 to 75 ppm. Uranium was successfully removed from solution in molten fluorides by use of a similar procedure. Approximately 2000 ppm uranium was precipitated from molten $LiF-BeF_2-ThF_4$ (67-18-15 mole %) by the addition of 3% by weight of beryllium oxide. Comparable results were also obtained using thorium oxide as the precipitant. (auth)

13932 THE LEACHABILITY OF FISSION PRODUCTS FROM URANIUM-IMPREGNATED GRAPHITE HEATED AT HIGH TEMPERATURE. Kazumi Iwamoto (Japan Atomic Energy Research Inst., Tokyo). Nucl. Sci. Eng., 18: 189-99 (Feb. 1964).

Irradiated UO_2–graphite fuel samples in which most of the fission products had recoiled into the graphite matrix were heated after irradiation, and then leached with nitric acid. The leachability of nongaseous fission products was influenced by fission product concentration, by irradiation temperature, and largely by temperature and period of the heating. A possible rate-controlling mechanism for the fission product loss during the heating is discussed, and the results obtained are compared with some of the earlier work. (auth)

13933 TRANSFORMATION THEORY OF SEPARATION CASCADES. I. THE CHARACTERISTIC QUANTITY REPRESENTATION OF THE GENERAL TRANSPORT EQUATION. Gerhard Dickel (Universität, Munich). Nukleonik, 5: 311-16(Dec. 1963). (In German)

A general transport formula, valid for all countercurrent separation methods, was formulated. In this formula the magnitudes characteristic for any arbitrary separation procedure are summarized in one characteristic quantity. This equation forms the basis for the transformation theory of separation cascades developed subsequently from the theory of extreme fields. (tr-auth)

13934 TRANSFORMATION THEORY OF SEPARATION CASCADES. II. THE EXTREMUM FIELD OF THE SEPARATION CASCADE. Gerhard Dickel (Universität, Munich). Nukleonik, 5: 316-21(Dec. 1963). (In German)

The problem of the optimum operating separation cascade was formulated from the most general viewpoint, and a diagram valid for all cascades was obtained with the help of the theory of the extremum field. The width constant was the abscissa and the height constant was the coordinate. Each of the extrema contained embodied a given cascade, which was characterized by a set cycle magnitude. The transverse surface of these extrema represent the lines of equal dissociation entropy. After conversion of the width and height constants to the real cascade mass, which are limited by the individual properties of a separation method, an easy cascade calculation can be made graphically. From the fundamental function of the extremum field, transformation theorems result, with whose help the cascade dimensions can be transformed in obvious steps. (tr-auth)

13935 THE SEPARATION OF TRACE AMOUNTS OF Pm, Eu AND Tb FROM MACROAMOUNTS OF Er. B. Kotlinska-Filipek and S. Siekierski. Nukleonika, 8: 607-16(1963). (In Polish)

The extraction coefficient of macroamounts of erbium from HNO_3 into 1.5M DBP in carbon tetrachloride was determined. The concentration of HNO_3 was changed from

0.7 to 13M and that of Er from 0.06M to 0.4M. The extraction coefficient of trace quantities of Tb in the presence of macroamounts of Er was also determined. Reversed phase partition chromatography with DBP as the stationary phase and HNO_3 as the moving phase was applied to the separation of tracer amounts of Pm, Eu, and Tb from as much as 500 mg of erbium nitrate. The column used for this separation was 10 cm long and its diameter was 1 cm. A method for the concentration of the effluent solution was developed. It was found that the amount of erbium eluted from the column depends on the concentration of HNO_3. Total removal of erbium from the column can be achieved by means of about 13M HNO_3. (auth)

13936 SOLVENT EXTRACTION OF CATIONS WITH ALKYL PHOSPHORIC ACIDS FROM SULPHATE SOLUTIONS. III. THE EXTRACTION OF U(VI) AND Fe(III) IN THE PRESENCE OF CATIONS CONTAINING A DIFFERENT THAN INERT GASES ELECTRONIC CONFIGURATIONS. Tadeush S. Urbanski. Nukleonika, 8: 649-56(1963). (In Russian)

The influence of metal sulfates of different electronic configurations (Co(II), Ni, Cu(II), Cd, and Mn(II)) on the extraction of U(VI) and Fe(III) with DDPA or D2EHPA. The extraction coefficients of U(VI) and Fe(III) were presented as a function of pH in equilibrium. The orders are given of the accompanying cations with respect to the extraction coefficients of U(VI) and Fe(III). (auth)

13937 A REFRACTOMETRIC STUDY OF THE INTERACTION BETWEEN DILUENTS AND MONO-DODECYL-PHOSPHORIC ACID. Lucja Kohman (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 657-66(1963). (In Polish)

A system for extraction of uranium, mono-dodecylphosphoric acid in a mixture of kerosene DDPA(m) and carbon tetrachloride (CCl_4), as well as the following binary systems: carbon tetrachloride and benzene or m-xylene, kerosene, dodecyl alcohol, and n-butyl alcohol were investigated. Curves relating Δn_D^{20} to the composition by volume exhibited extrema (in the case of aromatic compounds minima, and in the case of other ones maxima), thus indicating mutual interaction between the components. Changes in viscosity and density in relation to the composition and the infrared spectra of the DDPA(m)–CCl_4 system were also investigated. The latter confirmed the conclusions, which followed from the refractometric study. Deviation from additivity of the refractometric indexes was found to increase with the length of the hydrocarbon chain and its branches. The results confirmed the opinion that the refractometric method is well suited for examination of slight chemical interaction in a mixture difficult to be observed by means of other physico-chemical methods. (auth)

13938 REACTIONS OF CHLORINE WITH URANIUM RAW-MATERIALS. Jaroslaw Zienkiewicz (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 727-46(1963). (In Russian)

Studies on the reaction of molecular chlorine with uranium raw-materials in presence of molecular carbon and carbon monoxide show that a general uranium extraction method can be based on that reaction. The product of the reaction consists in a mixture of volatile derivates of uranium accompanied with the common and disseminated elements, whose application decides the economy of the process. (auth)

13939 THE EXTRACTION OF MINERAL ACIDS AND URANIUM SALTS BY ALIPHATIC SULPHOXIDES. II. THE EXTRACTION OF MINERAL ACIDS BY ALKYL SULPHOXIDES. Wincenty Korpak (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukelonika, 8: 747-54(1963).

The extraction of mineral acids with some alkyl sulfoxides was investigated. The formation of $R_2SO \cdot HNO_3$, $R_2SO \cdot HClO_4$, $R_2SO \cdot HCl$ and possibly R_2SCl_2 was found. Cryoscopic data indicate that the alkyl sulfoxides used in benzene do not polymerize. The extent of extraction of the acids by the sulfoxides can be arranged as follows: $HNO_3 > HClO_4 > HCl$. Differences in the extraction of the acids may be explained by their various behavior in concentrated solutions. It is therefore expected that similar differences should be observed during the extraction of uranyl chloride and nitrate with the sulfoxides. The possibility of indirect determination of the sulfoxides in organic diluents was indicated. (auth)

13940 CHARACTERISTICS OF INTRAPHASE EQUILIBRIUM IN URANYL NITRATE EXTRACTION BY ORGANIC PHOSPHORUS DERIVATIVES CONSIDERING THE ACTIVITY OF THE COMPONENTS IN THE ORGANIC PHASE. I. DETERMINATION OF ACTIVITY COEFFICIENTS IN DILUENT-TBP-$UO_2(NO_3)$-H_2O ACCORDING TO THE VAPOR PRESSURE. M. F. Pushlenkov and O. N. Shuvalov. Radiokhimiya, 5: 536-43(1963). (In Russian)

Descriptions are given of a device for measuring vapor pressure over solutions. The vapor pressure was measured for systems of TBP-diluent, diluent–$UO_2(NO_3)_2 \cdot 2TBP$, diluent–TBP–H_2O, and diluent–$UO_2(NO_3)_2 \cdot 2TBP$–$UO_2(NO_3)_2$–H_2O using chloroform dichloroethane, carbon tetrachloride, and hexane as diluents. Empirical constants were calculated for TBP, and uranyl nitrate activity in organic solutions. The relation between extracting agent activity and uranyl nitrate extraction by TBP with diluents was determined. (R.V.J.)

13941 CHARACTERISTICS OF INTRAPHASE EQUILIBRIUM IN URANYL NITRATE EXTRACTION BY ORGANIC PHOSPHORUS DERIVATIVES CONSIDERING ACTIVITY COEFFICIENTS OF ORGANIC PHASE COMPONENTS. II. EXTRACTION OF URANYL NITRATES BY A MIXTURE OF TRIBUTYL PHOSPHATE WITH DILUENT. M. G. Pushlenkov and O. N. Shuvalov. Radiokhimiya, 5: 543-50(1963). (In Russian)

Solvent extraction of uranyl nitrate and nitric acid from aqueous solutions by TBP mixtures with chloroform, dichlorethane, carbon tetrachloride, and hexane was studied. An analysis was made of the role of diluents in the uranyl nitrate phase distribution and of the effect of diluents on the activity of organic phase components. It was found that the nitric acid extraction coefficient depends on the aqueous phase composition, the concentration of extracting agent, and the nature of the diluent. Harned's coefficients for 4M nitric acid and sodium nitrate were determined on the basis of uranyl nitrate extraction effects. (R.V.J.)

13942 CHARACTERISTICS OF INTERPHASE EQUILIBRIUM IN URANYL NITRATE EXTRACTION BY ORGANIC PHOSPHORUS DERIVATIVES CONSIDERING COMPONENT ACTIVITY COEFFICIENTS IN THE ORGANIC PHASE. III. EXTRACTION OF URANYL NITRATE BY TBP, DBBP, BDBP, AND TBPO MIXTURES WITH DILUENTS. M. F. Pushlenkov and O. N. Shuvalov. Radiokhimiya, 5: 551-9(1963). (In Russian)

Solvent extraction of uranyl nitrate by TBP, DBBP, BDBP, and TBPO mixtures with chloroform, dichloroethane, and carbon tetrachloride was investigated. Extraction agent and diluent activity coefficients were estimated on the basis of diluent vapor pressure. An analysis was made of uranyl nitrate distributions between TBP, DBBP, BDBP, and TBPO in chloroform, dichloroethane,

and carbon tetrachloride and the aqueous phase, and effective extraction constants were determined. It was found that fewer ether oxygens in the extraction agent molecule result in an increased uranyl nitrate extraction, and that the diluent effect is exhibited in its reaction with uranyl nitrate extraction agent and disolvent. (R.V.J.)

13943 BEHAVIOR OF POLONIUM IN EXTRACTION PROCESS BY DI-N-BUTYLPHOSPHATE. N. I. Ampelogova. Radiokhimiya, 5: 562-74(1963). (In Russian)

Separation of Po from hydrochloric and perchloric acids by di-n-butylphosphate (DBP) solutions in CCl_4 was studied as a function of DBP concentration in the organic phase and hydrogen and chlorine ion concentrations in the aqueous phase at constant (3 and 6) ion strength. Diffusion of DBP between CCl_4 and 1.6, 3, and 6M $HClO_4$ and 2.5M HCl was determined as a function of DBP concentration. Constants for DBP dimerization in the aqueous phase and monomer and dimer distributions were determined. Extraction in perchloric solutions with HCl < 3M is described by: $Po(DBP)^{+3}_{3_B} + (NDBP)_{2_o} \rightleftharpoons [Po(DBP)_4 \cdot NDBP]_o + H^+_B$ and $Po[H(DBP)_2]^{+3}_{3_B} + (NDBP)_{2_o} \rightleftharpoons Po[H(DBP)_2]_{4_o} + H^+_B$. The constants for the reactions and for the complexing of Po with $(DBP)^-$ and $H(DBP)^-_2$ were calculated. The presence of 0.04M NDBP in 10% TBP solution in benzene does not affect Po distribution. (R.V.J.)

13944 CATION SALTING-OUT ORDER IN EXTRACTION PROCESSES. V. P. Ionov and V. I. Tikhomirov. Radiokhimiya, 5: 559-62(1963). (In Russian)

It was shown that the cation salting order (Mg > Zn > Cd > Ca) in thorium nitrates solvent extraction by 0.5M TBP in benzene takes the reverse order (Ca > Cd > Zn > Mg) with high HNO_3 concentrations. It was found that with higher salting cation hydration, acid extraction by TBP becomes higher. (R.V.J.)

13945 EXTRACTION OF URANYL NITRATE BY TRI-N-OCTYLAMINE NITRATE IN O-XYLENE AT 25°C. V. M. Vdovenko, T. V. Kovaleva, and I. A. Ryazanov. Radiokhimiya, 5: 619-22(1963). (In Russian)

The distribution of uranyl nitrate between aqueous solutions and solutions of trioctylammonium nitrate in o-oxylene was investigated. The data were used for calculating the extraction constant for $UO^{2+}_{2_w} + 2NO^-_{3_w} + (C_8H_{17})_3 \times NHNO_{3_o} \rightleftharpoons (C_8H_{17})_3NH \cdot UO_2(NO_3)_{3_o}$ as equal to 29.8 ± 1.3. (R.V.J.)

13946 BEHAVIOR OF POLONIUM DURING EXTRACTION FROM PERCHLORATE SOLUTIONS. N. I. Ampelogova. Radiokhimiya, 5: 626-8(1963). (In Russian)

Studies of the solvent extraction of Po by TBP and ethyl ether from mixed perchlorate solutions showed that the extraction of Po was most efficient at concentrations of $HClO_4$ not exceeding 2.5M; a further increase in $HClO_4$ concentration did not improve the extraction (this is in contrast to the behavior of Th, Zr, and Pm). The extraction of Po in 2.5M $HClO_4$ is given by the equation: $Po^{4+} + 4ClO^-_4 + pTBP \rightleftharpoons Po(ClO_4)_4 \cdot pTBP$. The extraction of Po from HCl + $HClO_4$ is almost identical to the extraction by pure perchloric acid solutions and indicates a complexing tendency with chlorine. The extraction of Po by ethyl ether at $HClO_4$ concentrations less than 2.5M is identical to the extraction by TBP. An increase in $HClO_4$ concentration inhibits the extraction. It was postulated that in the case of TBP extraction with a $HClO_4$ concentration from 2.5 to 3M polonium is found as a non-complex Po^{4+} ion which transforms into polonium perchlorate with the increase of $HClO_4$. (R.V.J.)

13947 SEPARATION AND RADIOCHEMICAL PURIFICATION OF Cd^{115} FRAGMENT FROM FISSION PRODUCTS. I. I. Naumova. Radiokhimiya, 5: 637-8(1963). (In Russian)

A method is suggested for separating radiochemically pure Cd^{115} isotope by precipitation with thiocyanate pyridine complex. The yield of cadmium is about 90% and the separation and purification time 3 to 4 hrs. (R.V.J.)

13948 INTERMITTENT PREPARATION OF Th X FROM RADIOTHORIUM BY ION EXCHANGE CHROMATOGRAPHY. K. B. Zaborenko, I. O. Bogatyrev, and D. Nittsol'd. Radiokhimiya, 5: 638-9(1963). (In Russian)

The separation of Th X(Ra^{224}) from RdTh(Th^{228}) by Th^{225} retention on an anion exchange resin with Ra^{224} remaining in the filtrate was described. The optimum conditions permitting a 100% retention of Th on a strong basic resin with negligible retention of Ra were achieved with a solution of 0.5 to 1.0N-nitric acid containing 80% methyl alcohol by volume. (R.V.J.)

13949 DETERMINATION OF THE EXCHANGE CONSTANT FOR SEVERAL ANIONS ON ANION EXCHANGE RESINS. V. I. Paramonova, A. N. Mosevich, and Yu. G. Zonov. Vestn. Lenningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 115-19(1963). (In Russian)

The values of interchange constants for $CH_3COO^- - NO^-_3$, $CH_3COO^- - UO_2(CH_3COO)^-_3$, $NO^-_3 - UO_2(CH_3COO)^-_3$ anions on anionic resins EDE-10P and AV-17 were obtained. The anions in respect to their affinity with the resins form the sequence $UO_2(CH_3COO)^-_3 > CH_3COO^- > NO^-_3$. This sequence is valid for both anion-exchangers, but the difference in absorption for the resin AV-17 is more marked than for EDE-10P. (auth)

13950 ON THE POSSIBILITY OF CONCENTRATION AND SEPARATION OF ELEMENTS USING THREE-PHASE EXTRACTION SYSTEMS. V. P. Zhivopistsev, I. N. Ponosov, and E. A. Selezneva (Perm State Univ., USSR). Zh. Analit. Khim., 18: 1432-5(Dec. 1963). (In Russian)

A study was made of the extraction of metal-thiocyanate complex anions with the use of an organic base-diantipyrilmethane. It is shown that under certain conditions during the extraction the organic solvent divides into two phases. One of them (the third phase) has a greater ability for extraction owing to a high concentration of the thiocyanate salt of the reagent. It was found that more than 15 trace elements can be concentrated simultaneously (Mo, W, Sn, Zn, Co, Fe, Cu, Ga, In, Ti, Zr, U, Hg, Cd, Bi). (auth)

13951 USE OF ARSENAZO I IN URANIUM EXTRACTION FROM DILUTE SOLUTIONS. A. P. Chumachenko and P. F. Andreev. Zh. Prikl. Khim., 37: 231-2(Jan. 1964). (In Russian)

Studies of extraction of uranyl nitrate by Arsenazo I with complex absorbent carriers (activated charcoal, silica gel, and aluminum oxide) showed from 10 to 50% higher adsorption compared with pure carrier. Complete uranium extraction was achieved over a wide range of pH when Arsenazo I was used. (R.V.J.)

13952 RARE METAL EXTRACTION BY CHEMICAL ENGINEERING TECHNIQUES. W. D. Jamrack. A Pergamon Press Book. International Series of Monographs on Chemical Engineering. Volume 2. New York, The Macmillan Company, 1963. 368p.

Information is included on: ore breakdown processes; ion-exchange purification; solvent extraction; dryway conversion processes; metal production by high temperature reduction techniques; molten salt electrolytic processes; iodide decomposition processes; and flowsheets from ore to metal for U, Th, Zr, Hf, Ti, Nb, Ta, V, and Be. (P.C.H.)

13953 SKHEMY I SREDSTVA AVTOMATIZATSII RADIOKHIMICHESKIKH PROIZVODSTV. (Designs and Means for Automatization of Radiochemical Installations).

A. A. Balashov, V. L. Lossievskii, V. N. Chernyshev, A. F. Shvab, and B. V. Shelemin. Moscow, Gosatomizdat, 1963. 187p.

Data are given on radiochemical processes and their role in nuclear technology. Automation in nuclear fuel processing on an industrial scale is discussed. Analytical methods and automatic solution control in radiochemical processes are reviewed. (R.V.J.)

13954 AQUEOUS REPROCESSING CHEMISTRY FOR IRRADIATED FUELS, BRUSSELS SYMPOSIUM, 1963. Paris, European Nuclear Energy Agency, 1963. 471p.

Twenty-six articles are included; separate abstracts were prepared for 24. Two articles on recent developments in solvent extraction by TBP and on organophosphorus compounds other than TBP for processing irradiated fuels and by-products were previously abstracted in NSA. (P.C.H.)

For abstracts of individual papers see: 13955, 13956, 13957, 13958, 13959, 13960, 13961, 13962, 13963, 13964, 13965, 13966, 13967, 13968, 13969, 13970, 13971, 13972, 13973, 13974, 13975, 13976, 13977, and 13978.

13955 ETHERS AS EXTRACTANTS. J. M. Fletcher (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). p.11-18 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

The qualities that characterize ethers as extractants are illustrated by the properties and behavior of the tri-ether, Butex, which was selected for use in the Windscale processing plant. Particular problems relating to this ether are enumerated and its performance discussed. The properties of ethers are such that they are suitable as diluents in amine systems to avoid third-phase formation: work with dibutyl cellosolve-amine mixtures is proving of interest. (auth)

13956 EXTRACTION BY DIBUTYL ETHER. W. Ochsenfeld (Kernforschungszentrum, Karlsruhe, Ger.). p.19-27 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

Some distribution coefficients of uranium and fission products between di-n-butyl ether (DBE) and aqueous solutions containing $Ca(NO_3)_2$ are given. Finally, DBE is compared with tributyl phosphate (TBP) as an extractive agent. The distribution coefficients and separation factors of uranium for zirconium, niobium, and ruthenium are in the same order of magnitude as TBP and DBE. DBE presents some advantages compared with TBP: uranium stripping is easier; there is no need for evaporation prior to the next extraction cycle, as with TBP; the less pronounced tendency of DBE to form emulsions is also an advantage. One of the disadvantages is the formation of peroxides, though they can be removed or their generation can be suppressed by working in an inert gas atmosphere. Another disadvantage of DBE is the use of calcium nitrate as the salting-out agent. (auth)

13957 AMINE SYSTEMS IN SOLVENT EXTRACTION. L. L. Burger, W. E. Keder, and A. S. Wilson (General Electric Co., Richland, Wash.). p.83-103 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

The dependence of extraction on concentration of amine and acid, solvent loading capacity, measurement of absorption spectra, and proton magnetic resonance data were employed to obtain further information on the nature of the amine system for actinide elements. (P.C.H.)

13958 PROPOSED FLOWSHEETS FOR AMINE SYSTEMS. M. Zifferero (CNEN, Rome). p.107-46 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

Factors affecting the choice of amine and diluent in amine solvent systems are described. The chemical and radiation stability of the solvent phase and its effects on extraction behavior are surveyed. A description of proposed applications and amine solvent flowsheets is included. (P.C.H.)

13959 QUATERNARY AMMONIUM SYSTEMS. E. Lopez-Menchero and L. Gehem (Eurochemic Co., Mol, Belg.). p.147-65 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

Studies on the distribution coefficient of plutonium(IV) between HNO_3 solutions and solutions of a quaternary ammonium nitrate, and of a tertiary amine nitrate in a solvent consisting of 10% octyl alcohol and 90% Shellsol-T (aliphatic hydrocarbon mixture), showed an inversion of the relative values of the distribution coefficients for these two extractants for the different HNO_3 concentrations in the aqueous phase. The case, in which the solutions were 0.16M either in lauryl-dimethyl-benzyl ammonium nitrate or in trilauryl-amine nitrate, the DPu(IV) – at 0.5M $[HNO_3]$ aq. was 0.4 for the quaternary and 1 for the tertiary amine; and at 4M $[HNO_3]$ aq. it was 50 for the quaternary and 14 for the tertiary amine. This suggests that it should easily be possible to find quaternary ammonium solvent systems with very good extraction and stripping properties for plutonium(IV). The fact that quaternary ammonium compounds can also be used in contact with non-acidic solutions gives them possibilities unpossessed by tertiary amines. (P.C.H.)

13960 EXPERIENCE AT MARCOULE IN THE PROCESSING OF IRRADIATED FUELS USING TBP AS SOLVENT. C. Jouannaud (Commissariat à l'Energie Atomique, Marcoule, France). p.167-88 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963. (In French)

There are three distinct solvent-extraction cycles at the Marcoule plant: fission product separation and plutonium-uranium separation; uranium decontamination; plutonium decontamination and purification. As a result of the experience gained, it is possible to define the operating conditions for these three cycles. Zirconium and ruthenium decontamination factors were measured. Observations were carried out for Pa^{233} and I^{131} when the fuels were processed after periods of short-cooling. All extraction is done in mixer-settlers. These contactors have been improved and the plant is now provided with equipment with better hydraulic performance, particularly as regards phase separation. Extra-flat, subcritical mixer-settlers have also been developed, and the advantages of such units for processing concentrated plutonium solutions are now well established. (auth)

13961 STUDIES MADE AT WINDSCALE ON TBP/KEROSENE SOLVENT PERFORMANCE AND CLEAN-UP. T. G. Hughes and D. W. Clelland (United Kingdom Atomic Energy Authority, Windscale Works, Sellafield, Cumb., Eng.). p.189-99 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

A brief description is given of the production scale experience at Windscale of solvent extraction by TBP/Kerosene, which has to date been used only for the low-active uranium and plutonium purification processes that

follow the Butex primary separation process. Considerable development work on TBP/Kerosene solvent performance has been undertaken in support of the New Separation Plant at Windscale, which is due to be commissioned later this year. Some aspects of this work are described, and details of proposed solvent cycles for the new plant are given. (auth)

13962 REVIEW OF RESEARCH AND DEVELOPMENT WORK AT EUROCHEMIC. R. Rometsch (Eurochemic Co., Mol, Belg.). p.207-18 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

In the first few years at Eurochemic emphasis was placed on development work connected with the plant project, such as adaptation of flowsheets, determination of missing data, testing of assumptions, and gaining technological experience. The results of flowsheet studies for the multi-purpose dissolver, the various extraction cycles, and waste handling are briefly reviewed. Among the possibilities investigated in this category are: a zirconium and Zircaloy dissolution process, by means of buffered solutions of hydrofluoric acid; the development of a plutonium separation and purification process using tertiary amines, and precipitation from organic solutions; and the use of quaternary ammonium salts for plutonium separation. Screening investigations have recently been started for processing fuel coated with graphite, carbon, or silicon carbide. (P.C.H.)

13963 CHEMICAL FLOWSHEET FOR TBP EXTRACTION AT THE EUROCHEMIC PLANT. E. Détilleux, A. Redon, J. Centeno, W. Drent, and R. de Witte (Eurochemic, Mol, Belg.). p.219-40 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963. (In French)

A brief description of the principal characteristics of the fuel elements to be reprocessed by Eurochemic and a general outline of the chemical process applied at the plant are followed by a theoretical discussion of the TBP cycle flowsheets. There are two such cycles: the first provides co-decontamination and separation of uranium and plutonium; the second completes the uranium decontamination. Whereas the second cycle resembles the second uranium cycle of a standard Purex process, the first is a variant of that process. The principal modifications are: adoption of a HAF feed solution with a relatively low uranium content in order to process fuels containing up to 5% U^{235} under the same working conditions; two successive scrub sections, one highly acid and the other of low acidity, mainly for the purpose of improving ruthenium and zirconium–niobium decontamination; adoption of the temperature effect, to increase fission product decontamination or reduce the A/O ratio during plutonium and uranium re-extraction in aqueous phase, which ensures a higher concentration of these elements. The uranium behavior and the influence of parameters such as acidity and temperature on fission product decontamination were investigated in the course of experiments conducted in laboratory-scale mixer-settlers or pulse columns. Typical uranium and nitric acid distribution curves are given for each unit, and discussed. The results of investigating the influence of acidity and temperature on ruthenium and zirconium–niobium decontamination under process flowsheet conditions are also discussed. (auth)

13964 EUROCHEMIC FLOWSHEET FOR THE FINAL PURIFICATION OF PLUTONIUM USING TRILAURYLAMINE. G. Rolandi, J. Van Geel, A. Geoffroy, and E. Détilleux (Eurochemic, Mol, Belg.). p.241-61 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963. (In French)

The principal characteristics of the solution entering the plutonium purification facility and the specifications of the end product are briefly described. The chemical process now being developed at Eurochemic is based on plutonium extraction by trilaurylamine (TLA), followed by direct precipitation of the plutonium contained in the TLA phase by means of oxalic acid. The work leading up to this flowsheet is briefly reviewed. Three different compositions of TLA solution were successively considered: 10% by volume of TLA in Shellsol-T (aliphatic diluent), with 5% octanol and without octanol; and 20% TLA in Solvesso-100 (aromatic diluent). The 20% TLA mixture was adopted, because it permits a plutonium concentration in the organic phase of at least 20 g/l without a third phase appearing, whereas with the other solutions, under the same acidity conditions, the concentrations did not exceed 6 g/l and 2.5 g/l, respectively. After studying the conditions for plutonium re-extraction by sulfuric acid, consideration was given to a process of direct precipitation from the organic phase. Hydrogen peroxide was first used as the precipitating agent, but was ultimately replaced by oxalic acid since plutonium(IV) oxalate gives a better yield and a precipitate of good quality. Laboratory tests now in course show that the process thus chosen satisfies the decontamination and yield requirements for final purification. (auth)

13965 STUDY OF FURTHER PURIFICATION OF PLUTONIUM ENRICHED FUEL ELEMENTS. R. Billiau, I. Lafontaine, N. Mostin, and E. Zamorani (Centre d'Etude de l'Energie Nucléaire, Brussels). p.263-78 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963. (In French)

The influence of certain factors on the dissolution, purification, precipitation and preparation of plutonium-bearing oxides, and the correlation between the precipitation conditions for different salts and the characteristics of the oxides obtained after calcination and densification are described. Operating conditions in a nitric acid-hydrofluoric acid dissolution medium were established for plutonium oxide and mixed uranium-plutonium oxides (clad or otherwise), providing both a high dissolution rate and a plutonium-bearing solution suitable for purification in ion exchange columns. During the purification cycle in Permutite SK resin columns (40-70 and 20-50 mesh) the maximum rates of plutonium fixation (with and without the presence of metal impurities) in 8 and 10 M nitric acid media, and the influence of metal impurities (iron, uranium, molybdenum, zirconium) on the resin capacity at different breakthroughs were determined. The DF's obtained after washing and elution range between 10^3 and 10^4 for uranium and zirconium, and are about 10^5 for iron. After a second purification cycle, the total DF for uranium is about 10^5. The precipitation of plutonium peroxide, oxalate and hydroxide from the purified plutonium-bearing solutions was studied; at the same time, the influence of precipitation conditions on the specific area, the particle and agglomerate sizes, and the tap density of the product after calcination were demonstrated. It was found that the initial precipitation conditions also have a bearing on sintering conditions, which must in every case allow the obtention of a sintered oxide of high geometric density. So far, only with an ammonium-precipitated hydroxide has it been possible to obtain average geometric densities of 10.7, after low-temperature sintering (1300°C) of powders calcined at ≤500°C. (P.C.H.)

13966 URANIUM(IV) NITRATE AS A REDUCING AGENT FOR URANIUM–PLUTONIUM SEPARATION. H. A. C. McKay, R. J. W. Streeton, and A. G. Wain (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). p.281-8 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

Uranium(IV) nitrate, stabilized by hydrazine (a nitrous acid destroyer), was used as a reductant for plutonium(IV) in separating uranium and plutonium in a tri-n-butyl phosphate (TBP) process. Factors of importance include: incomplete reduction of the plutonium, due to the comparative slowness of the reaction; losses of uranium(IV) by aerial oxidation at low acidities in the TBP phase; re-oxidation of plutonium(III) at aqueous acidities above about 2.5 M. These factors were studied in both batch experiments and mixer-settler runs. Systematic uranium(IV) partition coefficient measurements were made under the conditions likely to be found in a contactor. Mixer-settler runs in the presence of plutonium gave a promising separation of uranium and plutonium. (auth)

13967 SOME EXPERIENCE IN THE USE OF URANIUM(IV) NITRATE. B. Edwall, E. Détilleux, A. Redon, J. Centeno, W. Drent, and R. de Witte (Eurochemic Co., Mol, Belg.). p.289-94 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

Experimental investigations into the use of uranium(IV) nitrate as a reducing agent for plutonium in the partition cycle started in the middle of 1959. The early work was mainly concerned with the preparation and stability of uranium(IV) solutions. Flowsheet testing of the partition cycle began at the end of 1962. Two methods were used: the first consisted of mixer-settler tests using solutions of irradiated uranium; the second of tests with inactive uranium solutions using full-size pilot columns. The 8 m column of the inactive pilot plant was equipped with sampling points at distances of 50 cm along the column. These made it possible to study the distribution of uranium(IV) nitrate. When a hydrazine-stabilized uranium scrub solution of 20 g/l was introduced at the top of the column, a fairly rapid decrease in uranium concentration occurred along the column, due to extraction into the organic phase and/or re-oxidation. Determination of uranium was performed by spectrophotometry, coriometry, and x-ray absorption methods. Hydrazine analyses were made by bromometry. Analysis of uranium(IV) in the organic phase indicated that its stability was relatively low, and this necessitated very rapid sampling and analytical procedures. In spite of reduced stability, the distribution of uranium(IV) in plant-size columns indicated that the partition cycle can be performed using uranium(IV) nitrate as a reducing agent, thus avoiding the introduction of SO_4 and iron. (auth)

13968 CATALYTIC REDUCTION OF URANYL NITRATE SOLUTIONS. R. de Leone (CNEN, Rome). p.295-8 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

Catalytic reduction of uranyl nitrate solutions provides a very simple, cheap, and useful method of producing uranium(IV) nitrate solutions for use as reducing agents in plutonium-uranium separation. The following aspects of the method were investigated: catalyst, reducing agent, uranium and free nitric acid concentrations, and temperature. Platinum added as platinum black or carried on alumina powder or pellets is the best catalyst; hydrogen under normal or high pressure, or formic acid, can be employed as reducing agent over a wide range of uranium and nitric acid concentrations, the yield being constantly high. The stability of uranium(IV) nitrate solutions, produced by catalytic reduction and containing no stabilizer, was investigated and a mechanism involving a catalytic action of nitrous acid is proposed for the reaction between uranium(IV) and nitric acid. The use of catalytic reduction with formic acid in the PCUT reprocessing plant is briefly described. (auth)

13969 THE HEAD-END TREATMENT OF ZIRCALOY 2-CLAD URANIUM DIOXIDE FUEL ELEMENTS. G. Carleson (Aktiebolaget Atomenergi, Stockholm). p.299-312 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

Various methods proposed for the dissolution of Zircaloy-clad nuclear power fuel elements are briefly summarized. The advantages and disadvantages are discussed, and a comparison is made, taking into particular consideration problems such as suitability for industrial application, appropriate properties of product solutions for a subsequent solvent extraction process, dissolver corrosion, losses of fissile material, and final storage of the decanning waste in a concentrated and, if possible, solid form. The dry methods discussed are mechanical dejacketing and various high-temperature methods, such as electrolysis in molten salts, gas phase chlorination (Zircex), and the Thermox process. Thermox is a selective oxidation method, newly developed in Sweden. An outline is also given of a new modification of Zircex that permits the continuous and selective de-cladding and core dissolution of severely oxidized Zircaloy fuel elements. Wet dissolution methods were subjected to more intensive laboratory-scale development and testing on an engineering scale. The cladding is usually dissolved in hydrofluoric acid or ammonium fluoride, either pure or in mixtures with, for example, nitric, oxalic, or citric acid as well as with hydrogen peroxide. Particular emphasis is given to the Zirflex (NH_4F) process. Various physico-chemical problems in this process are considered, such as complexes and solubility curves, ammonia equilibrium and treatment of oxidized surfaces. An outline is given of a new modification of Zirflex. After chemical pretreatment to remove the oxidized surface, the Zircaloy is continuously dissolved in a rapidly circulating system at a constant and high free fluoride concentration. Dissolved zirconium salts are simultaneously precipitated by refrigeration in a special vessel. (auth)

13970 DISSOLUTION OF ZIRCONIUM IN A SODIUM FLUORIDE-CITRIC ACID SOLUTION. J. Van Caeneghem, Y. Marchant, and E. Détilleux (Eurochemic Co., Mol, Belg.). p.313-29 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963. (In French)

A method based on the decomposition of sodium fluoride by citric acid, thereby producing hydrofluoric acid is described. Attacked by the latter, the zirconium forms one or more complexes containing fluorine and citrate ions. This process, known as the Citriflex process, is now being studied. The principal experiments are described and the results discussed. The influence of the sodium fluoride and citric acid concentrations on the initial rate and the mean rate of zirconium and Zircaloy dissolution were investigated. By introducing oxidizing agents such as ammonium nitrate or nitric acid, it is possible to obtain total dissolution of the tin present in the Zircaloy and partial oxidation of the hydrogen released as the zirconium is dissolved. Identification of the complex or complexes thus

formed is not yet completed, and therefore no precise equation can be given for the reaction. Various problems connected with the possible use of this process for dejacketing zirconium- or Zircaloy-clad elements are discussed. (auth)

13971 THE USE OF INORGANIC ION EXCHANGERS FOR REPROCESSING PURPOSES. S. Ahrland (Univ. of Lund, Sweden). p.331-40 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

The properties of some basic salts and hydrous oxides were compared in order to find the materials best suited from various points of view for use as ion exchangers. Among the basic salts so far tried (with titanium(IV), zirconium(IV), and thorium(IV) as cations), zirconium phosphate definitely shows the most promise; among the hydrous oxides, most seems to be achieved by silica gel. To a certain degree, zirconium phosphate and silica gel also complement each other in effecting the desired separations of the different constituents of reprocessing solutions. (P.C.H.)

13972 DISSOLUTION PROBLEMS OF NUCLEAR FUELS CONTAINING HIGH PERCENTAGES OF MOLYBDENUM. W. Baehr (Kernforschungszentrum, Karlsruhe, Ger.). p.341-3 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

Certain problems arising in connection with the dissolution of molybdenum-containing nuclear fuels are described. Fuel elements with 20% Mo are difficult to dissolve completely in HNO_3. The large quantity of molybdic acid formed during the dissolution process considerably retards the dissolution times of the fuel elements. To obtain a high uranium concentration in the feed solution it is advisable to recycle the solution by a centrifuge. The clear solution, still containing unused HNO_3, is fed back to the dissolver through a condenser. The molybdic acid adsorbs about 10 to 20% of the uranium, which is recovered by washing with HNO_3 and dissolving the molybdic acid in NaOH. (auth)

13973 AQUEOUS PROCESSING. P. Regnaut (Commissariat à l'Energie Atomique, Fontenay-aux-Roses, France). p.347-60 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963. (In French)

Problems connected with aqueous processing of fuel elements are discussed. Improvements seem necessary in connection with: dissolution of cladding and new fuels (oxides, carbides, nitrides, ceramics, cermets and dispersions, plutonium fuels); improved solvent resistance to high activities; research on new solvents; reduction or reprocessing costs; storage of high-active wastes; improved safety; and solidification of fission product solutions. Special attention is given to the economics of aqueous processing. (P.C.H.)

13974 REVIEW OF NON-AQUEOUS REPROCESSING. M. D'Hont and J. Schmets (Eurochemic Co., Mol, Belg.). p.361-73 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

Developments in the principal methods for non-aqueous reprocessing are described. The pyrometallurgical procedures are outlined and volatilization methods, distinguishing between processes in gas phase and processes in liquid phase, such as molten salt treatment and the Nitrofluor process, are described. Generally speaking, the status of non-aqueous procedures is described as following up at a steady rate the progress of aqueous reprocessing. (P.C.H.)

13975 RECENT DEVELOPMENTS IN THE AREA OF REPROCESSING BY VOLATILIZATION. J. Broothaerts, G. Camozzo, J. Decock, et al. (Centre d'Étude de l'Énergie Nucléaire, Brussels). p.375-95 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963. (In French)

The development of methods of reprocessing by volatilization has involved intensive research on the properties of the halides of uranium, plutonium and other elements. The results suggest a fairly wide field of application for these new processes. It seems likely that they will be applied in the first place to uranium-aluminium and uranium-zirconium alloys and to ceramic fuels. (auth)

13976 PROCESSING OF IRRADIATED FUELS BY VOLATILIZATION IN THE FORM OF FLUORIDES. P. Faugeras and M. Bourgeois (Commissariat à l'Energie Atomique, Fontenay-aux-Roses, France). p.397-422 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963. (In French)

An outline of the principle of the process is followed by a brief review of work done in France since 1957. This has mainly been concerned with processing by the fluidized-bed method in the gaseous phase. In particular, the following fuels were studied: uranium–zirconium clad with Zircaloy; uranium–aluminum clad with aluminum; uranium–molybdenum clad with aluminum; uranium oxide; uranium–plutonium oxide clad with stainless steel. The projected active pilot plant for proving these methods with highly-irradiated fuels is also described. Lastly, in the light of the results obtained, the advantages and disadvantages of the process and its future potentialities are discussed. (auth)

13977 REPROCESSING OF FAST BREEDER REACTOR FUEL ELEMENTS. H. Vogg (Kernforschungszentrum, Karlsruhe, Ger.). p.423-4 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

Analysis of wet chemical reprocessing methods for fast reactor fuel showed that, at least for a first phase, reliance will have to be placed on wet methods. This raises engineering problems since required amounts of charge are in a transition area between mixer-settlers and pulsed columns. (P.C.H.)

13978 PRESENT AND FUTURE ROLE OF REPROCESSING IN THE FUEL CYCLE. F. L. Culler, Jr. (Oak Ridge National Lab., Tenn.). p.427-41 of "Aqueous Reprocessing Chemistry for Irradiated Fuels." Paris, European Nuclear Energy Agency, 1963.

Recent studies of very large reactor systems for distillative purification of sea water emphasized the great economic significance of plant capacity on unit costs in the fuel cycle. Further, the almost certain cost superiority of natural uranium burned in very large heavy water-moderated, light water-cooled systems (8700 Mwt—in stations of three) has been developed in a series of estimates of reactor and fuel cycle costs, where fuel cycle capacity was varied from 1 to 30 short tons of uranium/day. Costs of the fuel cycle pressurized light water, partially enriched reactors were compared with the natural uranium cycle at 10 tons/day to show the certain economic advantage of the natural uranium cycle. A study was also made of the fuel cycle cost incurred for plutonium recycle to reactors of similar design to the natural U–D_2O model. These studies and earlier abbreviations made of the costs of fuel element fabrication for the current nuclear power reactors point out the current high costs for fuel element

fabrication. When recycle of plutonium or U^{233} and thorium is necessary, these costs must increase because of the added cost of fabrication behind shielding and under α-tight conditions. Thus, in fuel reprocessing the problem of closing the cycle, of returning irradiated fissile and fertile material to fuel elements, should be taken as first order business. A new and promising process, the sol-gel, is reviewed. Sol-gel prepared oxide or carbide fuels, loaded into cladding tubes by vibratory compaction, may provide a simple and versatile process that can be coupled efficiently to the normal products of solvent extraction reprocessing. Because of the rapidly developing demand for heat sources in the range of 100 kw, the chemical reprocessing cycles may be provided with additional income from purified fission products and energetic α-emitting heavy elements. A prospectus for this demand is presented. A series of solvent extraction flowsheets for recovery of all fission products of package-power interest is given, and methods for neptunium recovery (for Pu^{238} production) are suggested. Curium-242 and curium-244 may also be important. (P.C.H.)

13979 FEED MATERIALS PRODUCTION CENTER REFINERY—KEROSENE-TBP PROCESS (Engineering Materials). (National Lead Co. of Ohio, Cincinnati). (CAPE-50)

The Feed Materials Production Center Refinery is used to process uranium ore concentrates to highly purified uranium trioxide (UO_3). This is accomplished by: digestion of the ore concentrates in nitric acid; extraction of the uranium from the resulting uranyl nitrate slurry with tri-butyl phosphate in pulsed, perforated-plate extraction columns; and denitration to UO_3 by calcination of the aqueous uranyl nitrate. Auxiliary facilities include a nitric acid recovery system for absorbing nitric oxide vapors, an organic solvent treating system that permits the recycling of the tributyl phosphate solvent, and a sump system for the precipitation and recovery of uranium values in waste liquor streams. (F.S.)

ENGINEERING

General

Refer also to abstract 15122.

13980 (HW-76606) USER'S MANUAL FOR TUBE FLEX. A GRAPHITE CHANNEL-PROCESS TUBE FLEXIBILITY AND STRESS ANALYSIS PROGRAM FOR THE IBM-7090 COMPUTER. F. J. Mollerus, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 20, 1963. Contract AT(45-1)-1350. 21p.

The program TUBE FLEX, in FORTRAN MONITOR for the IBM 7090, calculates tube bending moments, bending stresses and bending radii as well as the tube-channel reactions for a process tube in a typical Hanford graphite channel. Input preparation, output interpretation, and program limitations are discussed; and the theory is reviewed. Sample input and output are included. (D.C.W.)

13981 (IDA/HQ-63-1412(Vol.I)) PROCEEDINGS OF THE IDA PULSE-POWER CONFERENCE, FEBRUARY 4-5, 1963. VOLUME I. UNCLASSIFIED PAPERS ON INDUCTIVE ENERGY STORAGE, MAGNETOHYDRODYNAMICS EXPLOSIVE TRANSDUCERS, AND SWITCHING. (Institute for Defense Analysis, Washington, D. C.). Mar. 1963. Contract SD-50. 197p.

Separate abstracts were prepared for nine of the fifteen papers included. One other paper on energy storage in superconducting coils was previously abstracted in NSA. The other five papers deal with capacitive and inductive energy storage and switching for high-current d-c systems. (D.C.W.)

For abstracts of individual papers see: 14781, 14782, 14783, 14784, 15038, 15039, 15040, 15041, and 15042.

13982 (KAPL-M-6100) STRENGTH OF A BOLTED JOINT. L. Deagle, A. B. Briggs, and H. L. Hong-Moo (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 1964. Contract W-31-109-eng-52. 121p.

Results are presented of experimental and analytical investigations of a bolted joint. Both static and dynamic loading were investigated. Static loads were applied with hydraulic rams; dynamic loading was applied with the Navy Medium-Weight Shock Machine. The static and dynamic strains at various points in the structure were measured with electric resistance strain gages. Calculated values of the static and dynamic response of the structure are compared with the measured values. (auth)

13983 (NASA-TN-D-1711) NUMERICAL SOLUTION OF AXIALLY SYMMETRIC POISSON EQUATION; THEORY AND APPLICATION TO ION-THRUSTOR ANALYSIS. Vladimir Hamza (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). May 1963. 58p. (N63-16162)

The axially symmetric Poisson equation is solved for mixed boundary conditions by a method of successive approximations in which the differential equation is replaced by finite-difference equations. Properties of the resulting matrix are studied. The theory of "regular splittings" is applied, together with the cyclic Chebyshev semi-iterative method to solve the matrix equation. Also included is a numerical example, solved on an IBM-7090 computer, for a hollow, cylindrical ion beam. (auth)

13984 (ORNL-3535) ANALYSIS OF SIMPLY SUPPORTED GRIDS OF PERPENDICULAR BEAMS. F. J. Witt (Oak Ridge National Lab., Tenn.). Mar. 1964. Contract W-7405-eng-26. 42p.

An analysis of a rectangular grid of perpendicular beams simply supported at the ends is presented. Bending, shearing, and torsional effects of beams with arbitrary cross sections are taken into account, and the beams may be subjected to uniform or concentrated loads. An energy method is used in the analysis, and a matrix formulation for determining the unknown coefficients appearing in the Fourier series expression for the lateral deflection is given. This formulation is especially suited for computer application, and a computer program for performing the analysis is described. Data are presented for use in the design and evaluation of certain grid configurations. Applications to nonrectangular grids are also considered. (auth)

13985 (TID-4100(Suppl.20)) SUPPLEMENTAL INSERT SHEETS FOR ENGINEERING MATERIALS LIST. Richard E. C. Duthie, ed. (Division of Technical Information Extension, AEC). Feb. 1964.

Included are lists under critical assemblies, engineering equipment, hot laboratory equipment and structures, instruments, metallurgical equipment and processes, radiation instruments, nuclear reactors and facilities, particle accelerators, plant designs and processes, shielded containers, thermonuclear reaction devices, and specifications. (D.L.C.)

13986 (TID-4102) ENGINEERING MATERIALS LIST CUMULATIVE SUBJECT & CORPORATE AUTHOR INDEXES. Supplements 13-16. Richard E. C. Duthe, ed. (Division of Technical Information Extension, AEC). Jan. 1964. 42p.

This cumulation of the Contents, Subject Index, and Corporate Author Index to the TID-4100 List, covers the CAPE-numbered packages of engineering materials that have been announced in Supplements 13 through 16. (D.L.C.)

13987 (WAPD-TM-398) SEAL-SHELL-2—A COMPUTER PROGRAM FOR THE STRESS ANALYSIS OF A THICK SHELL OF REVOLUTION WITH AXISYMMETRIC PRESSURES, TEMPERATURES, AND DISTRIBUTED LOADS. C. M. Friedrich (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Dec. 1963. Contract AT(11-1)-Gen-14. 65p.

The ALTAC-3 computer program SEAL-SHELL-2, which determines stresses and deflections in thick or thin shells of revolution, is described. The shells are linear-elastic with bending, shear, and tensile strains. Pressures, temperatures, and distributed loads are axisymmetric. The theory for the program, in FORTRAN II for a 32,000-word computer, is presented. Sample problems are also included. (auth)

13988 ADVANCED BEARING TECHNOLOGY. Edmond E. Bisson and William J. Anderson (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). 1964. 514p. NASA-SP-38. $1.75(GPO).

This book strives to explain the fundamentals of friction and wear, fluid film bearings, and rolling-element bearings, and to show how bearing problems involving high temperature, radiation, vacuum, and corrosive fluids can be solved. A total of 14 chapters are included. Separate abstracts were prepared for three of the chapters which deal with bearing problems in space and with liquid metals

as working fluids in power plants and as lubricants. (D.L.C.)

For abstracts of individual chapters see: 13989, 13990, and 15602.

13989 FRICTION AND BEARING PROBLEMS IN THE VACUUM AND RADIATION ENVIRONMENTS OF SPACE. Edmond E. Bisson. p.259-307 of "Advanced Bearing Technology." Washington, D. C., National Aeronautics and Space Administration, 1964.

A general discussion is given of the friction and bearing problems that result from exposure of mechanisms to the vacuum or radiation of space. The emphasis is on self-lubricating materials and limited-life lubricants. Low evaporation rates are obtained with metals, some lubricating compounds, and Teflon. Experiments at 10^{-6} mm Hg gave excellent results for molybdenum disulfide and good results for silicones and silicone greases. Lubrication in the satellite TIROS II was based on the controlled loss of lubricant from a reservoir. Natural radiation should be no problem to oils and greases, but the advent of reactors may require greater radiation resistance. (D.L.C.)

13990 LUBRICATION OF BEARINGS WITH LIQUID METALS. William J. Anderson. p.469-96 of "Advanced Bearing Technology." Washington, D. C., National Aeronautics and Space Administration, 1964.

The advantages of using the cycle working fluid (which is liquid metal in space power plants) as the lubricant are outlined. Materials compatibility is expected to be a severe problem owing to the high chemical activity of the alkali metals. The merits of rolling-element, hydrodynamic, and hydrostatic bearings for liquid-metal applications are considered separately, and the results of various bearing experiments are described. The properties of bearing materials in liquid metals are discussed: compatibility, wear and seizure resistance, embeddability, conformability, and surface films. The properties of liquid metals as bearing lubricants are described. Finally, operating problems in space power plants using liquid metal lubricant are considered. (D.L.C.)

13991 RADIATION SENSING SYSTEM FOR AUTOMATICALLY GUIDING AND POSITIONING PLANES ON AIRCRAFT CARRIERS. William A. Savin (to U. S. Navy). U. S. Patent 3,124,690. Mar. 10, 1964. Filed Mar. 31, 1961.

A guiding apparatus is described that uses the detection of gamma rays to produce electrical signals that compensate for deviation from the predetermined path. The gamma source is in a sealed capillary tube mounted in a shield that is located on the aircraft carrier deck and is the path followed by the aircraft. (R.E.U.)

Applications of Nuclear Explosions

13992 (TID-3522(7th Rev.)) PEACEFUL USES FOR NUCLEAR EXPLOSIVES. A Selected Annotated Bibliography. Hugh E. Voress, William F. King (Division of Technical Information Extension, AEC), and Carl R. Gerber, comps. (Division of Peaceful Nuclear Explosives, AEC). Jan. 1964. 57p.

A bibliography of 270 references in abstracted form is presented which covers reports and published literature of the Plowshare Program through Jan. 2, 1964. The references are arranged under the following headings: general, excavation, natural resources development, and other applications. An author index is included. (D.L.C.)

13993 CRATERING AND RADIOACTIVITY RESULTS FROM A NUCLEAR CRATERING DETONATION IN BASALT. M. D. Nordyke and W. Wray (Univ. of California, Livermore). J. Geophys. Res., 69: 675-89(Feb. 15, 1964).

A summary of the cratering and radioactivity release data from project Danny Boy, an 0.42-kt nuclear cratering detonation in basalt, is presented. The detonation was at a depth of 33.5 m and produced a crater about 32.5 m in radius and 19 m deep. Comparison of the crater dimensions with past cratering results in basalt shows that the Danny Boy crater agrees with these data when $W^{\frac{1}{3.4}}$ scaling is used and an equivalence between chemical and nuclear explosives is assumed. Integration of the fallout pattern shows that about 4 per cent of the radioactivity produced in the explosion escaped from the crater and appeared as fallout. The disposition of the radioactivity in the crater area and in the fallout is given. On the basis of the results, it is concluded that both the cratering results and the radioactivity-release results are well within predictions made before the event. (auth)

13994 ATOMIC-AGE FRACTURING MAY SOON OPEN UP STUBBORN RESERVOIRS. Charles H. Atkinson and Mitchell A. Lekas. Oil Gas J., 61: 154-6(Dec. 2, 1963).

The possibility of using the energy from an underground nuclear explosion to stimulate production from stubborn petroleum reservoirs is discussed. It is mentioned that underground nuclear explosions produce cavities, the roofs of which generally collapse. They also fracture the rock beyond the cavity and produce heat, some noncondensing gas, and radioactive debris. In effect the explosion will create a huge wellbore into which the reservoir fluids will drain. Fracture types, heat effects, and radioactivity are discussed. (P.C.H.)

Facilities and Equipment

Refer also to abstract 15356.

13995 (ATN-64(9227)-3) GENERAL RESEARCH. ELECTRON BOMBARDMENT HEATING FOR ELECTROTHERMAL PROPULSION. K. E. Starner and W. R. Grabowsky (Aerospace Corp., El Segundo, Calif.). Feb. 3, 1964. 48p.

Electrothermal propulsion devices developed to date can be grouped into two classifications, namely, the arc jet and the electric resistance heated heat transfer propulsor. The former type features Joule heating directly in the gas; in the latter, a resistance heated refractory metal heat exchanger transfers heat to the propellant by conduction. The technique of high-voltage, low-current electron bombardment heating is introduced for the heat transfer thrustor. The electron bombardment approach is found to have inherent advantages for space applications and allows lifting of several restrictions found with resistance heating methods. A tantalum, electron bombardment type gas heater was built to research thrustor operation. Steady-state gas temperatures to 2700°K were produced with argon at a voltage-to-current ratio greater than 50. The device functioned successfully for a total operating time of approximately 50 hr. (auth)

13996 (GAT-P-31) INCIPIENT TRANSFORMER FAULT DETECTED BY COMBUSTIBLE GAS MONITORING PROGRAM AND ULTRA SOUND TESTS. C. I. Crawford and A. F. Wilson (Goodyear Atomic Corp., Piketon, Ohio). Oct. 31, 1963. Contract AT(33-2)-1. 14p. (CONF-429-1; CONF-430-1)

From 31st Annual Conference of Doble Clients, Boston, Jan. 1964 and Institute of Electrical and Electronics Engineers Winter Power Meeting, New York, Feb. 1964.

A description is given of the test methods used to monitor 26 power transformers rated 100,000 kva for combustible gas in the nitrogen, and the investigation of an incipient fault that was detected by these methods. Screen tests are performed with an explosimeter, and gas analysis is done by mass spectrometry. (auth)

13997 (NASA-TN-D-2171) EXPERIMENTAL EVALUATION OF STEADY-STATE CONTROL PROPERTIES OF AN ELECTRON-BOMBARDMENT ION THRUSTOR. Shigeo Nakanishi, Eugene V. Pawlik, and Charles W. Baur (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Feb. 1964. 59p.

The steady-state gains, or changes, in beam-current output with changes in thrustor inputs were investigated for a 10-centimeter-diameter electron-bombardment ion thrustor. A general leveling off of beam current as a function of an input variable was found at the upper range of each variable. At the design operating point, the filament-heating current exhibited the greatest sensitivity, or percentage beam-current output change for a percentage change in the input (2 to 4). Accelerator voltage showed the least effect (0.04) while discharge voltage, magnetic field, and neutral propellant flow exhibited about the same sensitivity (0.4 to 0.5). Some effects of nonlinearity are shown that may require consideration in the design of a closed-loop control system. (auth)

13998 (ORNL-3523(p.443-60)) FACILITIES AND EQUIPMENT. (Oak Ridge National Lab., Tenn.).

Operation of GCR-ORR loop No. 2 with a flux-calibration test stringer is reported for fueled-graphite spheres. Calculated values of the flux are shown to agree well with the measured values. Means for improving the flux level and distribution are considered. Additional inspections were made on the gas-bearing compressors being fabricated for GCR-ORR loop No. 2 and the operation of regenerative grease-lubricated compressors installed in loops 1 and 2 is reported. The use of specific property detectors is being studied as a means for measuring permanent gas impurities in helium at concentrations below 1 ppm. Evaluation studies are reported for the following instruments: thermionic ionization detector, radio-frequency ionization detector, beta-ray ionization detector, Lipsky detector, electron mobility detector, breakdown detector, and photoionization detector. (auth)

13999 (TID-7677(p.44-55)) THE ANALOG COMPUTER AS AN AID IN CRITICAL VENTILATION SYSTEM EVALUATION. T. W. Pickel (Oak Ridge National Lab., Tenn.).

Advantages of using analog computers in the analysis of air-handling systems are discussed and an illustration of an analysis of a simple system is presented. (M.C.G.)

14000 (TID-7677(p.73-85)) DESIGN CONSIDERATIONS FOR EXHAUST SYSTEMS INVOLVING RADIOACTIVE PARTICULATES. A. B. Fuller (Oak Ridge National Lab., Tenn.).

The dependability required of exhaust ventilation systems handling radioactive particulates makes it essential that: thorough investigations concerning needs be made, and good engineering practices be applied. A number of "designer shortcomings" are outlined, with references listed. Planning, reviewing, and designing such exhaust systems are discussed. (auth)

14001 (TID-7677(p.86-101)) CONTAINMENT AND VENTILATION SYSTEMS IN THE TRANSURANIUM PROCESSING PLANT. B. F. Bottenfield, J. P. Nichols, W. D. Burch, O. O. Yarbro, and W. E. Unger (Oak Ridge National Lab., Tenn.).

The unique features of the ventilation and containment systems incorporated into the Transuranium Processing Plant, under construction at the Oak Ridge National Laboratory, are described. This facility is designed to recover from irradiated target rods by solvent extraction and ion exchange techniques gram quantities of many of the heavy actinide elements for research. Containment of process solutions is insured by surrounding the equipment with multiple negative-pressure systems, including final containment by maintaining the entire building at a −0.3 in. pressure. The effects of operational and accidental activity releases from the facility are discussed. (auth)

14002 (TID-7677(p.484-93)) IN-PLACE TESTING OF HIGH-EFFICIENCY FILTERS AT ORNL. E. C. Parrish and R. W. Schneider (Oak Ridge National Lab., Tenn.).

In most exhaust systems the high-efficiency filter is the primary means of minimizing atmospheric contamination during normal operation or during the accidental release of radioactive particulate material. Any effective contamination-control program must include a routine test for measuring the filtration efficiency of each system with its operational filters in place. The program developed for testing filter systems in situ demonstrated the importance of this contamination-control technique. (auth)

14003 (TID-7677(p.522-4)) MAINTENANCE PROBLEMS ENCOUNTERED IN THE SERVICING OF FILTER INSTALLATIONS. W. S. Hornbaker (Oak Ridge National Lab., Tenn.).

Deficiencies in arrangement of filter installations from the point of view of maintenance requirements are discussed. Suggestions for improving the design of new installations are listed. (M.C.G.)

14004 (TID-7677(p.525-36)) A DISPOSABLE LIGHT CHAMBER FOR THE NAVAL RESEARCH LABORATORY PERCENT PENETRATION METER. E. C. Parrish and R. W. Schneider (Oak Ridge National Lab., Tenn.).

It is shown that the cost of measuring the efficiency of highly contaminated particulate filter systems can be reduced by substituting a disposable light chamber for the commercial unit supplied with the Naval Research Laboratory Percent Penetration Meter. Tests indicated that the disposable light chamber is a suitable substitute from the standpoint of performance requirements. The body of the disposable light chamber is made by cementing together two identical epoxy resin castings, the internal dimensions of which duplicate those of the commercial unit. Glass discs cemented in place seal the ends and thus contain contaminants within the disposable unit. The nontransmitting areas of the glass discs are covered with a nonreflective paper to reduce internal scattering of light. (M.C.G.)

14005 (TID-7677(p.553-71)) A SODIUM FLAME PARTICULATE TEST FOR HIGH-EFFICIENCY AIR-CONDITIONING FILTERS. R. G. Dorman, L. E. J. Yeates, and P. F. Sergison (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England).

This test method employs a particulate cloud of sodium chloride particles of sizes ranging from 0.02 to 2 micron equivalent diameter. The cloud is generated by spraying a 2% aqueous solution of common salt with subsequent liquid evaporation. The measurement of penetration depends on the characteristic sodium flame emission at 5890 Å which, over the range of concentration employed in this test, is directly proportional to mass of salt. The flame is viewed by a sensitive photomultiplier connected to a galvanometer and a steady reading is obtained in less than a minute. Penetrations of 0.001% at 1000 ft^3/min are measurable with

probable errors of ±0.0002% while penetrations of as little as 0.0004% may be estimated. Leaks in the filter material or sealing may be located by removing the effluent plate and searching the filter face with a probe connected to the flame photometer by a short length of rubber hosing. (auth)

14006 (TID-7677(p.572-602)) HUMIDITY TEST REPORT—NPR HIGH-EFFICIENCY FILTER BID EVALUATION. L. J. Nitteberg and R. K. Smith (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The first set of humidity tests was performed with saturated air at 200°F. Moisture separators were installed upstream of the filters thereby simulating the equipment installation in Cells "A" and "B" (Zone I exhaust) and Cell "D" (standby filters) of the 117-N Filter Building. Results of the tests showed a slight increase in pressure drop across the filters, but in no case did the total pressure drop exceed one inch water gage for flows corrected to 1000 cfm at 200°F. Upon drying, the filters were DOP tested and the required minimum efficiency of 99.95% was met with the exception of one damaged in handling. The second set of humidity tests was performed with supersaturated air at 200°F. To meet the test requirements, it was necessary to remove the moisture separators used during the first tests. These tests, being conducted without moisture separators, simulated equipment installation of Cell "C" of the 117-N Filter Building. Water droplets formed on both the upstream and downstream faces of the filters and, as would be expected, the pressure drops across the filters were higher than those of the previous tests. Filter pressure drops were approximately two inches water gage or less. Upon drying, the filters were DOP tested and the required minimum efficiency of 99.95% was met with the exception of those damaged in handling. The third set of humidity tests was performed to determine the ability of filters to meet conditions more severe than actually required test conditions. This third set of tests included spraying water directly on the filters in a 200°F saturated condition atmosphere. Results were inconsistent, but after two hours, three of five filters tested had pressure drop increases ranging from one to two and one-half inches of water. The other two plugged during this same length of time. All of the above tests were performed on clean filters. Burning tests verified that the adhesives used met the self-extinguishing requirements. (auth)

14007 (TID-7677(p.603-28)) AIR-FLOW PERFORMANCE IN FUME HOOD EXHAUST SYSTEMS IN CENTRAL RESEARCH AND ADMINISTRATION BUILDING 4500-SOUTH, ORNL. R. H. Forde (Oak Ridge National Lab., Tenn.).

A series of performance tests was conducted to determine causes and possible corrections for fume leakage problems in air-handling systems in Building 4500-South, ORNL. It was concluded that the convection currents induced by the heat inside the hoods were the basic cause of the disturbance in flow pattern. Various types of panels were installed to deflect the air flow inside the hood and to contain the air at the increased pressure resulting from internal heat sources. (M.C.G.)

14008 (AEC-tr-6352) DESIGN PROBLEMS OF LIQUID METAL INSTALLATIONS PIPELINES, EXCHANGERS, STEAM GENERATORS. P. Pouderoux. Translated for Oak Ridge National Lab., Tenn., from a paper Presented at "Liquid Metals Colloquium of the European Society of Atomic Energy Aix-en-Provence—Cadarache, Sept. 30–Oct. 1-2, 1963." 22p.

It is shown that some problems posed by the utilization of liquid metals are quite complex, but that solutions are available, although not always of a simple and economical type. The field thus remains open to numerous improvements. Among others, descriptions are given of the development of bellows expansion compensators, which will operate safely and permit a simplification of the piping arrangement, and of the elaboration of a ferritic steel with improved thermal qualities than austenitic steel, which would particularly be more economical. (auth)

14009 (AEC-tr-6354) MECHANICAL PUMPS FOR LIQUID METALS. J. Baumier and H. J. Gollion. Translated for Oak Ridge National Lab., Tenn., from paper Presented at "Colloquium of the European Society of Atomic Energy on Liquid Metals, Aix-en-Provence, Sept. 30–Oct. 2, 1963." 54p.

The possible solutions to the problems of pumping liquid metals by centrifugal pumps are reviewed. The review is oriented principally toward the problem of shaft seals and hydrostatic bearings. (auth)

14010 (EURAEC-785) INVESTIGATION OF THE CRITICAL BURNOUT WITH BOILING WATER. Quarterly Report No. 7, April 1–June 30, 1963. H. H. Agena (Maschinenfabrik Augsburg-Nurnberg A. G., Nuremberg). July 1, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 057-61-RDD. 11p. (A translation).

The assembly of the test circuit was concluded and hydraulic tested at 286 atm and 20°C. The installation was also operated at 150°C and a lower pressure as well as at lower temperature and 210 atm. A comparison of test values with the burnout equation stated by Iwaschkewitsch showed that this only seems to hold for homogeneous continuous flows. At low steam qualities and low water flows, large discrepancies were found between the equation and the test values. Comparisons when undercooling was applied at the outlet gave more favorable results. The computation of test data by means of an electronic digital computer was continued. (auth)

14011 LABORATORII DLYA RABOT S RADIOAKTIVNYMI VESHCHESTVAMI. (Laboratory for Working with Radioactive Materials). I. A. Reformatskii. Moscow, Gosatomizdat, 1963. 128p.

A general review is given of the rules and requirements for operating a laboratory handling radioactive materials. Descriptions are given of standard, special, and remote-control equipment used in hot laboratory cells. Means of protection, shielding, sanitation, and hygiene are discussed. (R.V.J.)

14012 HEAT EXCHANGERS. (to Sulzer Freres, Societe Anonyme). British Patent 950,310. Feb. 26, 1964. Priority date June 12, 1961, Switzerland.

A reactor heat exchanger is described that consists of a cylindrical container with an internal tube system connected to a plate that is perpendicular to a transverse plane through the cylinder. Means for connection to an external pipe of a heat exchange medium are described. (R.E.U.)

14013 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGER APPARATUS. Gerard Dupuy (to Commissariat a l'Energie Atomique). British Patent 950,517. Feb. 16, 1964. Priority date July 18, 1960, France.

A variable-surface heat exchanger of liquid-liquid type is described that provides pressurized-gas control of heat-exchange tube immersion depth. (R.E.U.)

14014 IMPROVEMENTS IN HEAT EXCHANGERS. Raymond Leslie Holmes and Frank Clare (to Clarke,

Chapman, and Co., Ltd.). British Patent 950,727. Feb. 26, 1964. Filed July 31, 1959.

A steam generator is described wherein the heat exchange elements are so devised that there is a small pressure drop on the gas passage side. The heat exchanger is in the form of a vertical hollow pack of tubes that are each spirally coiled in a single frusto-conical layer. (R.E.U.)

14015 IMPROVEMENTS IN OR RELATING TO DRIERS. Geoffrey Richard Plumb and Timothy John Hadfield (to United Kingdom Atomic Energy Authority). British Patent 950,901. Feb. 26, 1964. Filed Mar. 28, 1961.

A drier is described that may be used for powdered, granular, or gelatinous radioactive and/or toxic materials. A rotatable table with loading and unloading means and an infrared heater are described. (R.E.U.)

14016 IMPROVEMENTS IN AND RELATING TO PINTLE THRUST BEARINGS. (to Reactor Centrum Nederland). British Patent 950,967. Mar. 4, 1964. Priority date Mar. 23, 1960, Netherlands.

A pintle thrust bearing for the support of the rotor of an ultracentrifuge is described with provision for lubricant application. (R.E.U.)

14017 DEVICES IN ULTRACENTRIFUGES FOR DETECTING MOVEMENTS OF THE ROTOR. (to Reactor Centrum Nederland). British Patent 950,982. Mar. 4, 1964. Priority date Mar. 17, 1960, Netherlands.

A device is described for detecting and possibly rectifying unwanted behavior of individual centrifuge rotors due to wear of the point bearing. The rotor is mounted on a pintle thrust bearing and is maintained vertically by magnets. (R.E.U.)

Heat Transfer and Fluid Flow

14018 (AE-131) MEASUREMENTS OF HYDRODYNAMIC INSTABILITIES, FLOW OSCILLATIONS AND BURNOUT IN A NATURAL CIRCULATION LOOP. Kurt M. Becker, R. P. Mathisen, O. Eklind, and B. Norman (Aktiebolaget Atomenergi, Stockholm). Jan. 1964. 36p.

The hydrodynamic stability and the burnout conditions for flow of boiling water were studied in a natural circulation loop in the pressure range from 10 to 70 atg. The test section was a round duct of 20 mm inner diameter and 4890 mm heated length. The experimental results showed that within the ranges tested, the stability of the flow increases with increasing pressure, increasing throttling before the test section, but decreases with increasing inlet sub-cooling and increasing throttling after the test section. The measured thresholds of instability compared well with the analytical results by Jahnberg. For an inlet sub-cooling temperature of about 2°C, the measured burnout steam qualities were low by a factor of about 1.3 compared to forced circulation data obtained with the same test section. At higher sub-cooling temperatures, the discrepancy between forced and natural circulation data increased, so that at $\overline{\Delta}t_{sub}$ = 16°C, the natural circulation data were low by a factor of about 2.5. However, by applying inlet throttling of the flow the burnout values approached and finally coincided with the forced circulation data. (auth)

14019 (AEEW-R-261) HEAT TRANSFER PROPERTIES OF ORGANIC COOLANTS CONTAINING HIGH BOILING RESIDUES. A. G. Debbage, M. Driver, and P. R. Waller (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Jan. 1964. 32p.

Heat transfer measurements were made in forced convection with Santowax R, mixtures of Santowax R and pyrolytic high boiling residue, mixtures of Santowax R and OMRE Radiolytic high boiling residue, and OMRE coolant, in the range of Reynolds number 10^4 to 10^5. The data were correlated with the equation $Nu = 0.015\ Re_b^{0.85}\ Pr_b^{0.4}$ with an rms error of ±8.5%. The total maximum error arising from the experimental method and inherent errors in the physical property data was estimated to be less than ±8.5%. From the correlation and physical property data, the decrease in heat transfer coefficient with increasing high boiling residue concentration was determined. It was shown that subcooled boiling in organic coolants containing high boiling residues is a complex phenomenon and the advantages to be gained by operating a reactor in this region may be marginal. Gas bearing pumps used initially in these experiments were found to be unsuitable; a redesigned ball bearing system lubricated with a terphenyl mixture was found to operate successfully. (auth)

14020 (ANL-6734) TWO-PHASE (GAS-LIQUID) SYSTEM: HEAT TRANSFER AND HYDRAULICS. An Annotated Bibliography. Robert R. Kepple (Argonne National Lab., Ill.); and Thomas V. Tung (Illinois. Univ., Urbana). July 1963. Contract W-31-109-eng-38. 433p.

A bibliography of 2843 references in abstracted form is presented which covers the period 1950 to 1962. The references are arranged under the following headings: books and review articles, boiling, bubble, condensation, evaporation, equations of state, interfacial characteristics, mass transfer across phase boundaries, measurement techniques, nuclear reactor heat removal, and two-phase flow. An author index is included. (D.L.C.)

14021 (BAW-1291) NON-UNIFORM HEAT GENERATION EXPERIMENTAL PROGRAM. Quarterly Progress Report No. 2, September–December 1963. D. F. Judd, R. H. Wilson (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.); H. S. Swenson, R. A. Lee, and J. W. Ackerman (Babcock and Wilcox Co. Research Center, Alliance, Ohio). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3238. 16p. (EURAEC-982)

Experimental and analytical investigations are being conducted to determine the effects of irregular heat flow through reactor channels on the operating conditions that cause burnout (departure from nucleate boiling). Time was spent designing, procuring, fabricating, and formulating plans in preparation for the initial test work. The bus bars, loop piping, and Test Section No. 1 were completed and installed except for the final connections. The primary elements for the instrumentation and control modifications are ready for installation. Considerable effort was expended to obtain a satisfactory supply source for the non-uniform test sections. It appears that the azimuthal variation of heat generation will be between ±2.5 to 5%. Procedures are being formulated for checking out the equipment and loop modifications prior to test operations. (auth)

14022 (CEA-2316) PROPAGATION DE PETITES PERTURBATIONS DANS UN ECOULEMENT DOUBLE PHASE A UN SEUL CONSTITUANT. (Propagation of Small Disturbances in Two-Phase, One-Component Flow). J. Boure (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucleaires, Grenoble). 1963. 75p.

A small disturbance is shown to give rise to two waves: a pressure (sonic) wave and a continuity wave. Their propagation velocities are calculated. These velocities are independent of the disturbance amplitude. The sonic velocity is primarily a function of that one corresponding to the same medium with no flow and of the liquid phase velocity.

It is also a function of the physical properties of the phases on the saturation line, of the slip laws and of the void fraction. The continuity wave velocity is only a function of the slip laws, of the void fraction and of the velocity of either phase. It appears as two kinds of critical flow rates which are calculated. The void fraction and the liquid and gas velocities variations are calculated. These results are extended to the case of a real loop and an approximative method is given for the treatment of this case. (auth)

14023 (DPST/64-69-1) EFFECT OF ROD SPACING ON HEAT TRANSFER BOUNOUT. USAEC-AECL Cooperative Program Quarterly Progress Report, October–December 1963. R. H. Towell (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Jan. 1964. Contract AT(07-2)-1. 5p.

About 4 hours of operating time were accumulated on the 440-volt heaters in the surrounding-rod mockup by the end of the quarter. Heat balance and flow-ΔP measurements were made on the star-shaped channel with and without the central-rod mockup. Burnout tests with 0.050-inch rod spacing are delayed because of a leak in the seal weld between the surrounding-rod mockup and the pressure shell. (auth)

14024 (EURAEC-53) ACCOUNT OF ACTIVITIES FOR EURATOM [ON TWO-PHASE FLOWS], APRIL 1960. Special Report No. 1. C. Foure (Société Nationale d'Étude et de Construction de Moteurs d'Aviation. Division Atomiques, Suresnes, France). May 11, 1960. Work Performed under United States–Euratom Joint Research and Development Program. 63p.

Studies on load losses and vacuum fractions appearing in adiabatic, two-phase flows or in boiling liquids are summarized. Results of experiments in vertical tubes, cold (water–air mixture) and hot (boiling freon) show that it is preferable to use the Martinelli-Nelson calculation method in the former case and Dengler's calculation method in the latter. In cold experiments, the losses of load and the fraction of vacuum are measured. In the thermal experiments, the volume of vacuum cannot be measured; only the total loss of load can be extracted from the tests. Calculation methods by Lockhart-Martinelli, Martinelli-Nelson, Johnson-Abou Sade, Isbin, Dengler, Levy, Lottes-Marcheterre, and Bankoff are analyzed and compared. (N.W.R.)

14025 (EURAEC-153) HEAT TRANSFER AND PRESSURE DROP WITH STEAM–WATER SPRAY. A Critical Survey of Experiments Performed at CISE from November 1, 1959 to January 31, 1961. S. Bertoletti, J. Lesage, C. Lombardi, G. Peterlongo, M. Silvestri, G. Soldaini, and F. J. Weckermann (Centro Informazioni Studi Esperienze, Milan). Apr. 1961. Work Performed under United States–Euratom Joint Research and Development Program. 166p. (CISE-R-36)

Recent measurements of pressure drop, critical heat flux, and heat transfer coefficient performed with water–steam sprays at high pressure are discussed. Previous work in this field is briefly reviewed. An attempt is made at interpreting and correlating data. This work is performed under the CAN-1 program. (auth)

14026 (EURAEC-226) TESTS ON BURN-OUT IN BOILING WATER. Report MAN-Tka-09-07-61. Quarterly Report No. 1, Part I (Technical), September 1, 1961–December 31, 1961. (Maschinenfabrik Augsburg-Nürnberg A. G., Nuremberg). Jan. 2, 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract 057-61-RDD. 10p.

A research program was initiated on burnout in boiling water. A description is given of the designing of the test installation, high-pressure test section, and gamma density measuring device. (D.L.C.)

14027 (IS-810) PEAK HEAT FLUX IN NUCLEATE BOILING HEAT TRANSFER. Bernard P. Breen and George Burnet (Ames Lab., Ames, Iowa). Jan. 1964. Contract W-7405-eng-82. 59p.

The use of surface thermocouples in the measurement of boiling heat flux was investigated. Acetone was boiled from a steam-heated, polished, horizontal, stainless steel tube. Single wire thermocouples (diameter equal to 0.010 in.) were spot welded at different positions on the tube. Measurements recorded in nucleate and transition boiling showed characteristic differences which were analyzed and are reported. A point of strong discontinuity in the measured boiling surface temperature was evident when the thermocouple site went from nucleate into transition boiling. A method of promoting early transition boiling near the thermocouple site was developed. From the information contained in this thermocouple signal the approach to peak heat flux could be predicted. (auth)

14028 (KAPL-M-6106) AN ANALYSIS OF STEADY-STATE HEAT TRANSFER IN A SPRING-LOADED DRY SHIPPING CASK. F. T. Stetson (Knolls Atomic Power Lab., Schenectady, N. Y.) Feb. 11, 1964. Contract W-31-109-eng-52. 18p.

Results are presented of an analysis of heat removal from a KAPL spring-loaded dry shipping cask. The internal heat generation is provided by decay heat from test specimens irradiated in the MTR and ETR facilities. The results reported are maximum specimen temperatures, specimen temperature distributions, and the holder temperature distribution. The parameters varied were the internal heat generation rates, the metal-to-metal contact resistances, and the specimen loading in the holder. (auth)

14029 (KAPL-M-6108) ONE-DIMENSIONAL THERMAL TRANSPORT. W. B. Jordan (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 4, 1964. Contract W-31-109-eng-52. 14p.

A method for computing thermal transport in a one-dimensional heated channel is described. The process includes the effect of generation or collapse of steam, in that variable flow along the length of the channel is taken into account. (auth)

14030 (NYO-10489) [TWO-PHASE FLOW]. Quarterly Progress Report, January 1964. G. B. Wallis, D. A. Steen, S. N. Brenner, and J. M. Turner (Dartmouth Coll., Hanover, N. H.). Work performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3114. 74p. (EURAEC-920)

A theory of annular flow is shown to correlate void fraction data in a simple way within the range over which it is developed. The form of the theory is very similar to previous theories of one-dimensional two-phase flow. Preliminary investigations of the application of the theory to pressure drop prediction are discussed. Studies of the influence of pressure on the onset of droplet entrainment are reported. Void fractions in the slug flow regime are shown to vary over a wide range for the experimental conditions. At low velocities the existing theory is found to fall within the range of the data. (N.W.R.)

14031 (NYO-10577) TWO-PHASE-FLOW LONG-RANGE TEST PROGRAM. Monthly Progress Report, December 15, 1963–February 15, 1964. Report No. 454. M. Suo, A. Bergles, and M. Ziering (Dynatech Corp., Cambridge, Mass.). Feb. 24, 1964. Contract AT(30-1)-3304. 11p.

Dimensions and flow ranges of the test section of the

burnout test loop to be used for studying burnout during forced convection boiling in vertical channels are determined. The requirements for the d-c power supply equipment and modifications needed for the loop are discussed. (N.W.R.)

14032 (ORNL-3523(p.414-42)) EXPERIMENTAL INVESTIGATIONS OF HEAT TRANSFER AND FLUID FLOW. (Oak Ridge National Lab., Tenn.).

A study of static and dynamic phenomena relating to the formation and movement of beds of 1.5-in.-dia graphite spheres randomly arranged within a full-scale reactor core model and of the flow of a gas through this configuration is presented. The experiments encompassed measurements of the void fraction, angle of repose, levitation velocity, pressure distribution, velocity profile, sphere flow, and helium mass diffusion. Friction factors, calculated for all experiments, were found to be nearly independent of flow rate at higher values of the Reynolds modulus. The data for all beds, except when complete fluidization had occurred prior to the measurement, were in essential agreement. For the fluidized bed, the friction factor was found to be higher than observed in the other experiments despite the looser packing. This result was tentatively ascribed to differences in flow-passage alignment. The residence time of spheres in the core model was established by measuring the time, in terms of numbers of spheres discharged, to appearance at the exit of certain tagged and prelocated spheres. Preliminary data were obtained on the axial and circumferential distribution of helium introduced into the air flow from a point source on the vessel bottom; the results were qualitatively consistent. Flow and heat transfer in and around sphere clusters were studied by means of mass transfer from water-soluble spheres. Preliminary data on the spatial distribution in the voidage were obtained for a $\frac{1}{4}$-scale model by photodensitometric analysis of x-ray pictures through disks cut from a replication of the bed. Radial gas temperature and velocity measurements are reported for comparison of heat transfer from smooth and rough heated surfaces in annuli. (auth)

14033 (RTD-TDR-63-4130) INVESTIGATION OF LIQUID METAL BOILING HEAT TRANSFER. Richard E. Balzhiser, Robert E. Barry, Herman Merte, Jr., C. Phillip Colver, Andrew Padilla, Jr., and Lowell R. Smith (Michigan. Univ., Ann Arbor). Nov. 1963. Contract AF33(616)-8277. 241p. (AD-429182)

Analytical and experimental investigations were conducted on liquid metal boiling heat transfer. A study of saturated pool boiling of potassium in the nucleate regime supported the nucleate boiling data of Bonilla and coworkers at Columbia University. Values for the critical heat flux were determined experimentally over a pressure range of 0.1 to 22 psia. The data fall substantially above the theoretical predictions of Zuber and Tribus, Rohsenow and Kutateladze. The results are of the same magnitude as predicted by Noyes of Atomics International based on his experimental work with sodium at the lower end of this pressure range. The slope of the burnout flux versus pressure curve is much is much flatter than was predicted by Noyes on the basis of his data and a modified version of the hydrodynamic "correlations." At atmospheric pressure the burnout flux was found to be approximately 600,000 Btu/(hr)(sq ft). Significant temperature fluctuations were observed in the potassium pool during the course of these investigations. Superheating was attributed to the difficulty in establishing nucleating sites at the heat transfer surface in view of the strong wetting tendencies of the potassium and its high thermal diffusivity. The latter served to dissipate rapidly the energy required for nucleation in the boundary layer. Preliminary data in the stable film boiling regime have not yielded conclusive results. The studies to date have confirmed the superheating tendencies of alkali metal systems. Operation which was believed to have been in a stable film boiling regime produced fluxes much larger than predicted by analytical studies. Further data should be forthcoming from this apparatus shortly. The forced circulation studies have been plagued by a number of difficulties which have required substantial effort and time to resolve. Loop operation commenced in the spring of 1963, but was terminated shortly thereafter when persistent plugging difficulties in the primary potassium circuit prevented further operation. These difficulties were finally overcome during the summer months following the installation of a zirconium chip hot trap and potassium circulation has proceeded without difficulty since that time. An apparent break in the test section region has prevented the attainment of heat transfer results and has resulted in the contamination of the potassium circuit with sodium. The contamination was slight and it was possible to obtain two-phase pressure drop data and void fraction measurements with this apparatus. These results suggest that the Martinelli-Nelson correlation predicts pressure drops substantially lower than those observed experimentally at qualities up to 40%. Agravic studies with mercury have not produced data. The fabrication of the apparatus is nearing completion and initial check out procedures should begin shortly. The program calls for the pool boiling of mercury at pressures up to 300 psia and accelerations up to 20 times that of normal gravity. The apparatus is capable of producing fluxes up to 500,000 Btu/(hr)(sq ft). (auth)

14034 (TID-20166) BASIC EXPERIMENTAL STUDIES OF BOILING FLUID FLOW AND HEAT TRANSFER AT ELEVATED PRESSURES. Bimonthly Progress Report, November–December 1963. B. Matzner and J. Griffel (Columbia Univ., New York. Engineering Research Labs.). Jan. 27, 1964. Contract AT(30-3)-187. 35p.

Burnout points were obtained for four different internally cooled tubular test sections. These test sections included: two tubes with a 0.504-in. ID and 76-in. heated length, one tube with a 0.504-in. ID and 36-in. heated length, and one tube with a 0.245-in. ID and 36-in. heated length. The test sections were run with vertical upflow at pressures of 750, 1000, 1200, and 1500 psia, with mass velocities between 0.7×10^6 and 10×10^6 lb/hr-ft^2. This investigation established the existence of two different burnout regimes: nucleate boiling burnout and annular flow burnout. In the annular flow burnout region ($x \cong 0.10$) the following major characteristics were apparent: At mass velocities above 0.5×10^6 lb/hr-ft^2, burnout heat flux decreased with increasing mass velocity for the same exit conditions. As the diameter ($\frac{1}{4}$ to $1\frac{1}{2}$ in.), heated length (24 to 77 in.), and system pressure (750 to 1500 psia) were increased, there was a decrease in burnout heat flux. The effects decreased as the mass velocity was increased. There was no L/D effect. In the nucleate boiling burnout region the following major characteristics were apparent: Burnout heat flux increased with increasing mass velocity for the same exit conditions. As the diameter and length were increased, there was a very small decrease in burnout heat flux. In the subcooled boiling region, there appeared to be no effect of pressure. In the low exit quality region, there was a small decrease in burnout heat flux with increasing pressure. This effect decreased with increasing mass velocity. There was no L/D effect. (auth)

14035 (TID-20227) BASIC STUDIES IN GAS-SOLID SUSPENSION. Quarterly Report No. 63-3, October 1963–January 1964. Richard L. Peskin (Rutgers Univ., New Brunswick, N. J. Coll. of Engineering). Feb. 15, 1964. Contract AT(30-1)-2930. 17p.

Results obtained in the study of the gross fluid mechanics of a gas-solid suspension, in the helium diffusion study of the turbulent structure of the suspension, and in the theoretical analysis of the motion of a small particle in a turbulent fluid are summarized. Plans for modifying the apparatus for heat transfer study are discussed. Analysis of electrostatic effects in the suspension is underway. Instrumentation of the test loop is discussed. (N.W.R.)

14036 (UCRL-7532) CODE LISTINGS FOR THE FLOSS III—COMPATIBLE PROGRAMS INCLUDING FLOSS TYPE 3 AND TYPE 12, NOMAC, AND DASH N. Michael D. Mintz (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 9, 1963. Contract W-7405-eng-48. 83p.

Compatible programs are presented that solve a one-dimensional difference representation of the momentum, energy, continuity, and state equations for turbulent, compressible gas flow in hydraulic channels. About 30 varieties of channels can be accommodated. (T.F.H.)

14037 (UCRL-10556) TURBULENT EXCHANGE OF MOMENTUM, MASS, AND HEAT BETWEEN FLUID STREAMS AND PIPE WALL. Darshanlal T. Wasan and Charles R. Wilke (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley). Mar. 1, 1963. Contract W-7405-eng-48. 24p.

A new correlation is presented to describe mass and heat transfer to a fluid in a fully developed turbulent flow in a pipe. The correlation differs from earlier empirical relations in that it is based on a theoretical continuous eddy-viscosity distribution from the wall to the center of the pipe. Transfer rates calculated from the new correlation are in excellent agreement with experimental data on mass and heat transfer to fluid streams. (auth)

14038 (EURAEC-897) EFFECT OF BURN-OUT ON A CIRCULAR CYLINDRICAL TEST SECTION WITH FLUX FOCUSING. Special Report No. 13. (Société Nationale d'Étude et de Construction de Moteurs d'Aviation, Suresnes, France). Sept. 17, 1963. Work Performed under United States–Euratom Joint Research and Development Program. 24p. (A translation)

An analysis is made to determine the temperature transient distribution in a thick tube, externally heated (constant heat flux), when internal cooling suddenly stops (simulation of burnout). For an initial heat flux of 4000 kw/m^2 through the inside wall of a copper tube (R_1 = 5 mm – R_2 = 50 mm) it is shown that during the first five seconds an increase of temperature of 100°C occurs at the inside wall. (auth)

14039 (EURAEC-898) SWIRL FLOWS IN BOILING WATER: SYNTHESIS OF TESTS RELATIVE TO TWO-PHASE ADIABATIC VERTICAL FLOWS (AIR-WATER) WITH AND WITHOUT TWISTED TAPES. Special Report No. 14. (Société Nationale d'Étude et de Construction de Moteurs d'Aviation, Suresnes, France). Oct. 10, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 058-61-7-RDF. 53p. (A translation)

An attempt was made to gather and correlate all the results of hydrodynamic experiments in straight or swirl flows of an air-water mixture. Different geometries included round channels of 10, 20, and 30 mm internal diameter; annular channels, 11 × 30 mm; and four-rod clusters of the SENN type. They were tested at atmospheric pressure and ambient temperature on a loop operating in half-open circuit. A gamma absorption technique was used in the measurement of void fractions and the results were in good agreement with those obtained with the electrocitycal "puff" method. Among all the correlations investigated, the Martinelli-Lockhart curves seemed the best to match the results for all geometries. A good agreement was shown also with the representations based on the theory of Lottes and Mondin. Discrepancy from average curves was less in the case of flow with twisted tapes (10 to 17%) than with flow without twisted tapes (13 to 30%). (auth)

14040 (EURAEC-899) SWIRL FLOW IN BOILING WATER—TEST LOOP FOR STUDYING SWIRL FLOW IN BOILING WATER AT A PRESSURE OF 70 BAR. Special Report No. 15. (Société Nationale d'Étude et de Construction de Moteurs d'Aviation. Division Atomique, Suresnes, France). Oct. 7, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 058-61-7 RDF. 116p. (A translation)

A closed circuit test loop was designed to enable the phenomena connected with boiling water under a forced circulation due to a pressure of 70 bars and at a temperature of 285°C to be studied. A description is given of the loop, the circuits and measurement means, and the way in which these various parts work. (auth)

14041 (EURAEC-900) SWIRL FLOWS AND CRITICAL FLUXES IN BOILING WATER AT 70 BARS. Special Report No. 16. (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Suresnes, France). Oct. 8, 1963. Work Performed under United States–Euratom Joint Research and Development Program. 72p. (A translation)

The experiments performed at atmospheric pressure in tubular test sections and four-heated-rod clusters with and without twisted tapes have been undertaken at high pressure (70 bars – 285°C). With the four-rod test section, values of heat flux and mass velocity were limited to 3000 kw/m^2 and 1000 kg/m^2-sec. A preheater and a cooler allow variations of the inlet conditions (maximum quality 15%–maximum subcooling 6%–ΔT_{sbc} = 18°C). At constant mass velocity, critical heat flux increase with swirl flow varies from 20 to 35% following experimental conditions (flow rate-inlet quality . . .). Plots of critical heat flux as function of exit quality show for a given flow rate a sharp decrease of critical heat flux for a certain exit quality. For a given quality, critical heat flux decreases when mass velocity increases. The general shape of the curves remains unchanged with swirl flow. However, the curves are shifted toward higher heat fluxes and higher qualities. At constant mass velocity, a critical heat flux increase leads to an increase of exit quality and boiling efficiency. This last plot shows more dispersion for straight flow than for swirl flow. (auth)

14042 LOCAL HEAT-TRANSFER COEFFICIENTS ON A UNIFORMLY HEATED CYLINDER. H. C. Perkins, Jr., and G. Leppert (Stanford Univ., Calif.). Intern. J. Heat Mass Transfer, 7: 143-58(Feb. 1964).

Local heat transfer coefficients from a uniformly heated cylinder with water in cross flow are presented and compared with analytical predictions. The influence of channel blockage was investigated and a correction is presented for the effect of blockage on both the local and average heat transfer. The variation of viscosity with temperature across the boundary layer is also considered and its effect empirically correlated by means of a viscosity ratio. Reynolds numbers from 2000 to 120000; Prandtl numbers

from 1 to 7; surface-to-bulk temperature differences from 20 to 120°F; and blockage ratios from 0.208 to 0.415 were used in the tests. Local heat transfer coefficients were determined by measuring the temperature variation of the tube wall with a thermocouple welded to the inner surface. Analysis of the heat transfer in the laminar boundary layer uses integral methods with the Pohlhausen velocity profile in the momentum boundary layer and a third order temperature profile in the thermal boundary layer. A comparison was made between these results and previously published methods for the case of constant heat flux at the wall. (auth)

14043 EFFECT OF PRESSURE AND MASS FLOW RATE ON BURNOUT HEAT FLUXES IN A WATER AND STEAM-WATER MIXTURE FLOW IN TUBES. V. E. Doroshchuk and F. P. Lantsman (All-Union Dzerzhinskii Research Inst. of Heat Engineering, Moscow). Intern. J. Heat Mass Transfer, 7: 187-90(Feb. 1964).

Burnout heat fluxes in a flow of a water and steam–water mixture in cylindrical tubes 8 mm ID over a wide range of working fluid parameters were determined experimentally. In all cases burnout heat fluxes were found to decrease subcooling of water to boiling point, with increased steam content and pressure. The effect of mass flow rate on q_{bo} is more complex. (auth)

14044 A PHYSICAL MODEL FOR NUCLEATE BOILING HEAT TRANSFER. E. Ruckenstein (Polytechnical Inst., Bucharest). Intern. J. Heat Mass Transfer, 7: 191-8(Feb. 1964).

An equation for the heat transfer coefficient from a horizontal surface to a boiling liquid is established starting from a physical model for the nucleation and hydrodynamical processes. (auth)

14045 FORCED-CONVECTION BURNOUT. W. R. Gambill. Nucl. Safety, 5: No. 2, 157-65(Winter 1963-64).

A review is given of current developments regarding burnout for the following types of flow in forced-convection systems: subcooled, bulk-boiling, and swirl-flow. Related studies are also considered. (D.L.C.)

14046 BOUNDARY CONDITIONS FOR PARALLEL CHANNEL FLOW. J. F. Thorpe (Univ. of Kentucky, Lexington). Nucl. Sci. Eng., 18: 329-34(Mar. 1964).

A method of formulating boundary conditions for heat-transfer and flow-redistribution calculations for parallel-channel reactor arrays is discussed in which the stagnation streamline is used to define fictitious channel extensions upstream and downstream of the original parallel-channel configuration. This procedure is equivalent to defining a new parallel-channel configuration for which the boundary conditions are more clearly defined. A comparison of the calculated hydraulic parameters with the associated experimental results shows that the method is essentially correct. (auth)

14047 LIQUID-METAL HEAT TRANSFER. R. D. Brooks (General Electric Co., Cincinnati) and C. F. Bonilla. Nucleonics, 22: No. 3, 43-8(Mar. 1964).

Heat transfer aspects basic to Rankine-cycle liquid-metal SNAP systems are discussed for forced circulation, boiling, and condensation. 46 references. (R.E.U.)

14048 CRITICAL HEAT LOAD IN FORCED CONVECTION OF MONOISOPROPYLBIPHENYL IN TUBES AND DUCTS. Yu. P. Shlykov, A. I. Abramov, A. D. Leongardt, and V. D. Mikhailov. Teploenergetika, No. 2, 78-81(Feb. 1964). (In Russian)

Results are given from experimental studies of critical heat loads in forced monoisopropylbiphenyl flow. The critical heat load for 6 to 8 mm ducts varied from 3.7 to 4.8×10^6 kcal/m^2·h with a 6.3 m/sec flow rate and 124 to 190°C underheating and from 2.7 to 3.6×10^6 kcal/m^2·h with 120 to 195°C underheating. Flow rates in 10-mm diameter, 150-mm long tubes were 4 and 8 m/sec with underheating from 0 to 194°C. The results for these conditions are tabulated and analyzed. (R.V.J.)

14049 GENERALIZED EXPERIMENTAL DATA ON CRITICAL HEAT LOAD IN FORCED CONVECTION OF UNDERHEATED FLUID IN CYLINDRICAL TUBES. A. N. Ryabov and B. R. Berzina. Teploenergetika, No. 2, 81-7 (Feb. 1964). (In Russian)

A simplified physical model was developed, and a generalized relation was derived for forced underheated flow in 4- and 2-mm ID tubes. The relations describe the critical heat load with an accuracy of ±30%. (tr-auth)

14050 ON THE STAGNATION TEMPERATURE IN A TWO-PHASE TURBULENT JET IN A HIGH-VELOCITY GAS FLOW. V. N. Kalashnikov (Moscow Inst. of Oil and Gas Tech.). Zh. Tekhn. Fiz., 34: 174-82(Jan. 1964). (In Russian)

Stagnation temperature distribution in a two-phase turbulent jet formed by fluid injection into a high-velocity gas flow was analyzed. (R.V.J.)

14051 ON THE STRUCTURE OF SMALL-SCALE MAGNETOHYDRODYNAMIC TURBULENCE. L. S. Marochnik. Zh. Tekhn. Fiz., 34: 183-5(Jan. 1964). (In Russian)

It is shown that the growth of magnetic field at $R_m < 1$ (where R_m is Reynold's number) is possible when the scale of intrinsic ion and electron turbulence is less than the mean Larmor radius. It is also shown that under such conditions the Cowling theorem on the impossibility of a stationary two-dimensional dynamo is in error. (tr-auth)

14052 THE GROWTH OF A THERMAL BOUNDARY LAYER IN THE ABSENCE OF WALL SHEARING STRESS. R. J. Nickerson (Stevens Inst. of Tech., Hoboken, N. J.). New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-324, 7p, $1.00. (CONF-102-37)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

As a first step in the analysis of the flow processes and the energy transfer in the constrictor of an electric arc nozzle, a two-dimensional thermal-boundary layer growing along the centerline of a channel is studied. The centerline temperature is assumed to be constant, that is the centerline is taken to be a plane heat source at constant temperature. By a method of successive approximations the influence of confining walls on the velocity and enthalpy distributions is determined. (auth)

Materials Testing

14053 (CONF-356-10) FACTORS IN RADIOGRAPHY AT ENERGIES BELOW 400 kvp. R. W. McClung (Oak Ridge National Lab., Tenn.). [1962]. Contract [W-7405-eng-26]. 26p.

From 1963 American Society of Metals/Metals and Materials Show, Cleveland, Oct. 1963.

23rd National Convention of the Society for Nondestructive Testing.

The factors which affect the attainment of optimum results in radiography are radiation source, specimen, film-screen combination, film processing, and their mutual relationships. A general review is presented of radiographic practice and the effects of variations in the factors,

at energies below 400 kvp, on radiographic contrast and sensitivity. (D.L.C.)

14054 (DP-851) NONDESTRUCTIVE TEST STATION FOR ZIRCALOY-CLAD REACTOR FUEL. Leslie E. Goodwin and Herbert D. Hendricks (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Oct. 1963. Contract AT(07-2)-1. 19p.

A nondestructive test station was constructed to inspect Zircaloy tubes and Zircaloy-clad reactor fuel pieces for cladding defects. The test station includes a feeder to spiral the fuel pieces past the sensing transducers of a number of eddy current and ultrasonic instruments which measure wall thicknesses and indicate flaws. The station is adaptable to either solid or tubular fuel pieces with diameters between 1 and 3½ inches and lengths between 2 and 10 feet. Operation can be in air or under water and the complement of test transducers is easily changed to fit particular test situations. (auth)

14055 (HW-79553) BROADBAND ELECTROMAGNETIC TESTING METHODS. PART III. PARAMETER EXTRACTION. H. L. Libby and K. W. Atwood (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 1963. Contract AT(45-1)-1350. 57p.

A multiparameter electromagnetic or eddy current test method and a prototype tester are described that permit the extraction and separation of multiple parameters or variables of a test specimen. The applicable signal analysis theory is reviewed, and principles of the multiparameter eddy current test are given. A four-parameter laboratory test apparatus used in a simulated test to demonstrate the principles of operation of the method is described. Test results from this equipment are given in which small variations of three parameters in a simulated test specimen were successfully identified and extracted. (auth)

14056 (HW-SA-3307) CURRENT HANFORD ULTRASONIC RESEARCH AND DEVELOPMENT PROGRAM. D. C. Worlton (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Jan. 3, 1964]. Contract AT(45-1)-1350. 28p.

A survey is presented of recent trends and new developments in ultrasonic research at Hanford. Investigations of Lamb waves are discussed. The validity and applications of Lamb's theory are considered. The work on transducer analysis is described. (D.L.C.)

14057 THE INSPECTION OF THIN-WALLED STAINLESS STEEL REACTOR GRADE TUBING. R. S. Sharpe and S. Aveyard. J. Iron Steel Inst. (London), 201: 856-62 (Oct. 1963).

An inspection procedure is recommended for high-integrity stainless tubing suitable for fuel element sheathing making use of an ultrasonic technique as a primary inspection supplemented with visual inspection and a specially designed optical probe for the bore. It is emphasized that wherever possible natural defects should be used as standards for setting the inspection sensitivity and defining the reject level. A precise ultrasonic interference micrometer was developed to determine local wall thickness variations. (Rev. Metal Lit., 21: No. 1, Jan. 1964)

14058 ISOTOPE CAMERA. Lloyd I. Shure (to Picker X-Ray Corp., Waite Mfg. Div., Inc.). U. S. Patent 3,124,689. Mar. 10, 1964. Filed Sept. 14, 1959.

A portable remote-control camera is described that uses radiant energy to photograph the internal structure of an object. A radioactive source is provided with means of lowering from and replacement in a shield. (R.E.U.)

Protective Structures

14059 (AD-416475) BODY MOTIONS OF A BURIED ARCH SUBJECTED TO BLAST LOADING. Technical Note N-486. J. R. Allgood and D. DaDeppo (Naval Civil Engineering Lab., Port Hueneme, Calif.). Aug. 16, 1963. 50p.

An approximate method is developed for predicting the deflections of the footings of a buried arch subjected to a blast wave traveling along the surface. Results from the theory are compared with measured values from Operation Plumbbob Structure 3.3a. The influence of the dominant parameters is discussed. It is shown that duration of loading is exceedingly important in governing the magnitude of footing deflections. The theory is presented in a form suitable for use in design. (auth)

14060 (ORNL-3513) MEASUREMENTS OF RADIATION INTENSITIES IN VERTICAL CONCRETE-LINED HOLES AND AN ADJOINING TUNNEL AT THE TOWER SHIELDING FACILITY. V. R. Cain, C. E. Clifford, and L. B. Holland (Oak Ridge National Lab., Tenn.). Mar. 1964. Contracts W-7405-eng-26; AF(04-694)-62-2; and OCD-OS-62-145. 91p.

Fast neutron and gamma-dose rates within 4-ft-dia., 20-ft-deep, concrete-lined holes were measured at the Tower Shielding Facility. The radiation source was the Tower Shielding Reactor II (TSR-II) enclosed in a shield that modified the neutron to gamma ratio of the reactor leakage spectrum to more closely resemble that of a weapon spectrum. The holes were located at horizontal distances of 100, 228, and 450 ft from the reactor. From the hole at 100 ft extended a reinforced concrete-lined tunnel, 6 ft high, 2½ ft wide, and 20 ft long, with its ceiling 10 ft below ground level. The experimental measurements consisted of vertical traverses in the three holes and horizontal traverses in the tunnel. The parameters varied included distance from the reactor, the angle of elevation of the reactor with respect to the horizontal at the hole, and the material and thickness of the shield over the hole. Reactor elevation angles ranged from 15 to 90°. The shields over the holes were concrete, iron, and laminated iron and concrete slabs. (auth)

Vacuum Engineering

14061 (ORNL-3509) HIGH VACUUM FLANGE TEST OF A BAKEABLE ALUMINUM WIRE SEAL. J. D. Redman (Oak Ridge National Lab., Tenn.). Mar. 1964. Contract W-7405-eng-26. 33p.

As a part of the development work associated with the design of vacuum components for the Thermonuclear Project, a program was initiated for the testing of high vacuum bakeable flange and gasket designs for leak-tight sealing requirements. The flange and gasket components, chosen for the initial study because of the simplicity in design and low yield point of the gasket material, consisted of the fully annealed, type 1100, aluminum alloy compressed between plane flange surfaces which had a 32 μ in.-rms finish. Leak-tight sealing of the 99% aluminum, 10-inch wire was found to be dependent on the yield point and creep properties of the alloy. It was demonstrated, (1) that sealing was accomplished when the bolt loaded flange exceeded the yield point of the strain hardened gasket, and (2) the life of the gasket was dependent on the rate of deformation during thermal cycling between room temperature and 250°C. It was possible to maintain a satisfactory vacuum seal [$<10^{-9}$ torr liter-sec^{-1}-(gasket in.)$^{-1}$] for more than 18 thermal cycles with four hours per bake at the elevated tempera-

ture. Initial sealing of this 0.086-in. diameter gasket was achieved with approximately 0.028-in. gasket deformation and a force of 1500 lbs (linear in.)$^{-1}$ or (7½ tons-in.$^{-2}$). The maximum loading force required to achieve a seal (i.e., to cause plastic flow) was approximately 8½ tons · in.$^{-2}$, or 3000 lbs (linear in.)$^{-1}$ of gasket. (auth)

14062 (UCRL-11226) PROPOSED STANDARDS FOR GRAPHIC SYMBOLS IN VACUUM TECHNOLOGY. Finn S. Reinath (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 27, 1964. Contract W-7405-eng-48. 10p. (CONF-395-1)

From American Vacuum Society, Chicago, Feb. 1964.

Some standards proposed to the Standards Committee of the American Vacuum Society are presented. (D.C.W.)

14063 INFLUENCE OF GAS QUANTITIES DETERMINED WITH AN OMEGATRON ON FIELD ELECTRON MICROSCOPY DOWN TO 10^{-12}mm Hg USING W WITH Zr AND Be. E. Wurster. Thesis, Stuttgart, Technische Universität, 1963. 112p. $2.00(Gmelin, AED-DISS. 63-105). (In German)

The design and construction of an ultra high vacuum apparatus for a field emission tube down to 10^{-12} mm Hg is described. Vacuum measurements in this range with an Omegatron are more reliable than measurements with ionization manometers. A thin Zr layer was evaporated on a W needle. A Zr layer of 100–200 Å gave a reduction of the emission potential of W from 4.55 to 2.58 ev. The influence of hydrogen on field emission was also studied. Results of investigations of Be surfaces with a field emission microscope are given. (Gmelin Inst.)

14064 HANDBOOK OF HIGH VACUUM ENGINEERING. H. A. Steinherz. New York, Reinhold Publishing Corporation, 1963. 366p. $11.75.

The design, construction, and operation of high-vacuum systems are discussed. Subjects covered include materials of construction, components for producing and measuring high-vacuum, leak detection, and system design. Applications described include vacuum furnaces, coating, and space simulation. (R.E.U.)

14065 SUBLIMATION AND ION PUMPING IN GETTER-ION PUMPS. R. G. Herb, T. Pauly, R. D. Welton, and K. J. Fisher (Univ. of Wisconsin, Madison). 26p. (CONF-340-13)

From American Physical Society 1963 Autumn Meeting, Chicago, Oct. 1963.

A large variety of methods was studied for evaporation and sublimation of titanium. For use in getter-ion pumps, sublimation appears to be clearly superior to evaporation from the molten state. A number of getter-ion pumps were built and used for various applications. Each utilizes a plasma-containing grid as a source of electrons for heating titanium rods. The grid also provides the necessary ionization for the pumping of inert gases. Consideration is also given to effects of geometry, scaling, pressure, and recombination rates on ionization and pumping by the grid. (auth)

GEOLOGY AND MINERALOGY

General

14066 (HW-80086) GROUND WATER ANALOG TEST MODEL. M. D. Erickson and R. A. Walker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 2, 1964. Contract AT(45-1)-1350. 14p.

A test model of an electric analog simulation of the ground water beneath the Hanford Project was constructed to determine the safety of radioactive waste ground disposal operations. The 662-node model operated satisfactorily, and no major problems were encountered in the construction. The analog data were compared with predicted results with a maximum error of 10%; an inter-grid reaction was found to be causing errors, and a uniform grid size should be used throughout the network. (D.L.C.)

14067 (NYO-7243) INVESTIGATIONS IN ISOTOPIC GEOCHEMISTRY. Annual Progress Report No. 9. J. Laurence Kulp (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory. Geochemistry Lab.). Jan. 1964. Contract AT(30-1)-1669. 317p.

Research is reported on an isotopic study of lead in sedimentary pyrite, helium in magnetite, zircon ages from the Precambrian of sourthern Norway, age determinations on crystalline rocks of northern Cascade Mountains, potassium–argon ages of Laramide intrusives, and potassium–argon isotopic ages from southeastern Connecticut and Westchester County, New York. (M.C.G.)

14068 ISOTOPIC COMPOSITION OF STRONTIUM IN CARBONATITES. D. K. Bailey (Trinity Coll., Dublin and Geophysical Lab., Washington, D. C.). Nature, 201: 599 (Feb. 8, 1964).

The source of strontium-bearing carbonatites is discussed for the Keshya intrusive limestone in terms of the sial. (R.E.U.)

14069 A REVIEW OF ATOMIC ABUNDANCES IN CHONDRITES AND THE ORIGIN OF METEORITES. Harold C. Urey (Univ. of California, San Diego). Rev. Geophys., 2: 1-34(Feb. 1964).

A review of the sources of analytical data for the chondritic meteorites is given, and the latest data, particularly for the minor elements, are tabulated. Though the comparison of the chondrites is remarkably constant as compared with terrestrial rocks, important variations in the concentrations of certain major and minor constituents occur, which make it impossible to conclude that any one type of chondrite could have been produced from another by simple physical processes. This is true for the carbonaceous, enstatitic, and the high- and low-iron-group chondrites. The origin of these chondrites is discussed with reference to suggestions about the origin of the solar system. Only very complicated processes can account for the detailed characteristics of these objects. The possibility that the carbonaceous chondrites and particularly Wiik's type 1 of this group are the primitive material from which the meteorites and planets originated is considered, and it is concluded that these objects as a group cannot be such material. (58 references). (auth)

14070 THE VARIATION OF THE DEUTERIUM CONTENT OF NATURAL WATERS IN THE HYDROLOGIC CYCLE. Irving Friedman, Alfred C. Redfield, Beatrice Schoen, and Joseph Harris (Geological Survey, Denver and Woods Hole Oceanographic Inst., Mass.). Rev. Geophys., 2: 177-224(Feb. 1964).

Exploratory data from more than 1000 analyses of the distribution of deuterium in waters of the North American continent and the surface oceans contiguous to the continent are presented. The elementary theory of the processes that appear to explain the changes in the deuterium content of natural waters is developed. Quantitative expressions of the deuterium fractionation that can be expected to occur are presented for all phases of the hydrologic cycle from the evaporation of water from the oceans, its precipitation as rain and snow, and its travel back to the sea. Processes such as the freezing of water under equilibrium and nonequilibrium conditions, the evaporation of water from closed lakes and from lakes with an outlet, the formation of fog, frost, and dew are also discussed. The regional characteristics of the surface waters of North America are described and interpreted as reflecting the history of the water in the course of the hydrologic cycle. (auth)

Natural Radioactivity and Fallout

Refer also to abstracts 14115, 14133, 14138, 14147, and 14148.

14071 (CONF-67-37) THE AEC PROGRAM OF ATMOSPHERIC RADIOACTIVITY AND FALLOUT RESEARCH. Alfred W. Klement, Jr. and Joshua Z. Holland (Division of Biology and Medicine. Fallout Studies Branch, AEC). [1963]. 11p.

From Health Physics Society 8th Annual Meeting, New York, June 1963.

The Atomic Energy Commission's research program on atmospheric radioactivity and fallout is reviewed. The main purpose of the research program is to provide an increasingly complete and sound scientific basis for the prediction of radiation doses to man that may result from the introduction of radioactive material into the atmosphere. Techniques and computation models for making such predictions are discussed. Emphasis is placed on studies of world-wide transport and distribution phenomena associated with fallout from weapons tests and low-altitude local problems arising from industrial and laboratory operations. The program is conducted through research contracts with universities, industrial organizations, and interagency agreements with other government agencies and AEC facilities. A list is appended of current participants in the program. (C.H.)

14072 (EUR-481.i) MISURE DI RADIOATTIVITA' AMBIENTALE, ISPRA, 1962. (Measurements of Ambient Radioactivity, Ispra, 1962). M. De Bortoli, P. Gaglione, A. Malvicini, and E. Van Der Stricht (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy).

In 1962 the Safety Service of the Ispra Establishment of the Euratom Joint Nuclear Research Center carried out measurements which are briefly described with data on the concentrations of Sr^{90} and Cs^{137} in air, fallout, lake waters, animal bones and the food chain. (auth)

14073 (NP-13473) FALLOUT IN NEW ZEALAND. Quarterly Report, July–September 1963. (New Zealand. National Radiation Lab., Christchurch). 15p. (NRL-F10)

Data are summarized from measurements of fallout ra-

dioactivity in samples of air, rain water, and milk collected in New Zealand during 1963. (C.H.)

14074 (SC-RR-64-70) FALLOUT REPORT: BETA-GAMMA RADIOACTIVITY IN AIR AT SANDIA LABORATORY, JULY THRU DECEMBER 1963. R. E. Womelsduff (Sandia Corp., Albuquerque, N. Mex.). Mar. 1964. Contract AT(29-1)-789. 13p.

The gross beta-gamma radioactivity (expressed as micromicrocuries per cubic meter) of air samples collected by Environmental Health Division of the Sandia Laboratory of Sandia Corporation during the second half of 1963 is reported. (auth)

14075 (SCPRI(T)-98) SURVEILLANCE DE LA RADIOACTIVITE SUR LE TERRITOIRE FRANCAIS DE 1961 A 1963. (Monitoring of Radioactivity in French Territory from 1961–1963). (France. Service Central de Protection contre les Rayonnements Ionisants, Paris). 23p.

A series of tables and diagrams shows the averages of the results of radioactivity-measurements carried out by the SCPRI from 1961 to 1963 upon atmospheric dusts (at ground-level and at 12000 meters altitude), rains, river-waters and the food-chain. Several autoradiographs and γ-spectra complete these data. A map determines the distribution and coordinates of the SCPRI's sampling-stations on the French territory. (auth)

14076 NATURAL RADIOACTIVITY OF SOILS. V. L. Baranov (Inst. of Geochemistry and Analytical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol., No. 1, 159-63 (Jan.-Feb. 1964). (In Russian)

The estimation of artificial soil radioactivity from the difference of total radiation assayed radiometrically and radiation of potassium computed from its content in the soil can be regarded as quite valid. However, as a standard of potassium radiation in the soil, use should be made of a soil sample with a definite potassium content rather than of potassium salts. But to assay the soil content in certain radioisotopes, both natural and artificial, use should be made of chemical-analytical or radiochemical methods. The conventional radiometric technic without nuclear spectroscopy cannot substitute a quantitative assay of the major components of soil radioactivity, such as U, Th, K, and the conclusions based on the readings of radiometric devices might be at variance with the actual pattern and thus devoid of scientific significance. (auth)

14077 COMMENTS ON PAPER BY S. PENN AND E. A. MARTELL, 'AN ANALYSIS OF THE RADIOACTIVE FALLOUT OVER NORTH AMERICA IN LATE SEPTEMBER 1961.' Elmar R. Reiter (Colorado State Univ., Fort Collins); and REPLY. Samuel Penn (Air Force Cambridge Research Labs., Bedford, Mass.) and E. A. Martell. J. Geophys. Res., 69: 786-90(Feb. 15, 1964).

A critique is presented of an analysis by Penn and Martell (J. Geophys. Res., 68: 4195-207(1963)), in which it was concluded that practically all the fallout in the southeastern U. S. in late Sept. 1961 resulted from radioactivity vented to the atmosphere from an underground nuclear test at the Nevada Test Site on Sept. 15, 1961. A reply to the critique is also included. (T.F.H.)

14078 COMMENTS ON PAPER BY S. PENN AND E. A. MARTELL, 'AN ANALYSIS OF THE RADIOACTIVE FALLOUT OVER NORTH AMERICA IN LATE SEPTEMBER 1961.' L. Machta, R. J. List, and K. Telegadas (Weather Bureau, Washington, D. C.); and REPLY. Samuel Penn (Air Force Cambridge Research Labs., Bedford, Mass.) and E. A. Martell. J. Geophys. Res., 69: 791-5(Feb. 15, 1964).

A critique is presented of an analysis by Penn and Martell (J. Geophys. Res., 68: 4195-207(1963)), in which it was concluded that practically all the fallout in the southeastern U. S. in late Sept. 1961 resulted from radioactivity vented to the atmosphere from an underground nuclear test at the Nevada Test Site on Sept. 15, 1961. A reply to the critique is also included. (T.F.H.)

14079 COMMENTS ON PAPER BY S. PENN AND E. A. MARTELL, 'AN ANALYSIS OF THE RADIOACTIVE FALLOUT OVER NORTH AMERICA IN LATE SEPTEMBER 1961.' Luther B. Lockhart, Jr. (Naval Research Lab., Washington, D. C.); and REPLY. Samuel Penn (Air Force Cambridge Research Labs., Bedford, Mass.) and E. A. Martell. J. Geophys. Res., 69: 796-9(Feb. 15, 1964).

A critique is presented of an analysis by Penn and Martell (J. Geophys. Res., 68: 4195-207(1963)), in which it was concluded that practically all the fallout in the southeastern U. S. in late Sept. 1961 resulted from radioactivity vented to the atmosphere from an underground nuclear test at the Nevada Test Site on Sept. 15, 1961. A reply to the critique is also included. (T.F.H.)

14080 PENETRATION OF ^{90}Sr AND ^{137}Cs IN DEEP LAYERS OF THE PACIFIC AND VERTICAL DIFFUSION RATE OF DEEP WATER. Yasuo Miyake, Katsuko Saruhashi, Yukio Katsuragi, and Teruko Kanazawa (Meteorological Research Inst., Tokyo). J. Radiation Res. (Japan), 3: 141-7(Sept. 1962).

Vertical penetration of Sr^{90} and Cs^{137} down to 5000 m depth was confirmed in the western North Pacific. Surface values of these radionuclides range from 0.6 to 3.1 $\mu\mu$C/l for Sr^{90} and from 0.8 to 4.8 $\mu\mu$C/l for Cs^{137}, while at 5000 m depth both nuclides of about 0.1 $\mu\mu$C/l were determined. From the vertical variation in the concentration of radionuclides, the vertical diffusion coefficient from 200 m to 4000 m depth was calculated and the value of 200 was obtained. Time required to attain practically a homogeneous vertical distribution of substances put in the western part of the north Pacific Ocean would be a few hundred years. (auth)

14081 THE CONCENTRATION OF CARBON-14 IN ETHANOL. Tunahiko Sidei (Kyoto Univ.), Takenobu Higashimura, and Osamu Yamada. J. Radiation Res. (Japan), 3: 153-7(Sept. 1962).

For evaluating the yearly variation of C^{14} concentration in diet, radioactivities of C^{14} in ethanol were measured by liquid scintillation counting. Samples used were ethanol produced by fermentation from various vegetables and their data of photosynthesis ranged from 1949 to 1960. After purification from alcoholic beverage or ethanol of chemical grade, they were mixed into toluene scintillator and were counted by a low level liquid scintillation counter. Increase in C^{14} concentration, which was caused by the artificial production of C^{14} from nuclear test explosions, was remarkable from 1955 and the rate of increase was 4% per year. (auth)

14082 MEASUREMENTS OF RADIOACTIVITY IN NISHIYAMA DISTRICT, NAGASAKI, JAPAN. Kenji Takeshita (Kyushu Univ., Fukuoka). J. Radiation Res. (Japan), 3: 177-81(Sept. 1962).

Studies on the detection of the long-lived radioactive fallout due to the A-bomb explosion in Nagasaki were carried out in Nishiyama district in 1959. Mud collected near the Nishiyama water reservoir was treated chemically. The radioactivity of one sample was 20 times as much as the natural background, and its beta and gamma components of the sample were also measured. (auth)

14083 ATMOSPHERIC FALLOUT IN THE PERIOD OF ATMOSPHERIC NUCLEAR TEST BAN TREATY. Vilem Santholzer (Charles Univ., Hradec Kralove, Czechoslovakia). Jaderna Energie, 10: 11-13(Jan. 1964). (In Czech)

On August 5, 1963 in Moscow the partial nuclear weapon test ban treaty was signed. The latest megaton tests were carried out in summer 1962. Atmospheric fallout is shown to exist even now and it was concluded that this demonstrates that a stratospheric reservoir was built, which will act as a source of fission products during a definite time in the future. (auth)

14084 GAMMA-RAY SPECTROMETRY OF FRESH AND OLD FALLOUT FISSION PRODUCTS. V. Havlovic (Charles Univ., Königgrätz, Czechoslovakia). Kernenergie, 7: 49-53(Jan. 1964). (In German)

Fresh and old fission products in fallout were analyzed by gamma spectrometry and those nuclides in the fission product mixture, which emitted gamma radiation, were determined. From the spectra the dependence of the composition of the fission product mixture on age was ascertained. (tr-auth)

14085 METEOROLOGICAL INFLUENCES ON LONG-LIVED ATMOSPHERIC RADIOACTIVITY CONCENTRATION AS ANALYZED IN STUDYING MEASURING DATA FROM SUMMER 1961 TO SUMMER 1963. W. Marquardt (Meteorologische Observatorium Wahnsdorf, Radebeul, Ger.). Kernenergie, 7: 54-8(Jan. 1964). (In German)

After a short description of methods of measuring atmospheric radioactivity, the variation of the long-lived activity in the air from the summer of 1961 to the summer of 1963 is discussed. In the bounds of the common circulation process between the stratosphere and troposphere it was assumed that the radioactive aerosols cast in the stratosphere by nuclear weapons tests at high latitudes sinks rapidly into the troposphere and produced the autumn maxima in 1961 and 1962, while the aerosols from tests in lower latitudes reaches the troposphere only in the next spring. The appearance of a distinct spring maximum in 1963 and its absence in 1962 are thus explained. The strongly diminished radioactive concentration in the air during fogs was statistically established by comparison of values on days with fog and days without fog. "Hot particles" could be determined at the measuring place used only up to 4 months after suspension of nuclear weapons tests. For the same time period the specific activity of individual rainfalls is given. Showers had a greater specific activity than widespread rain. A graphic representation as well as a table underline the close relationship between precipitation and total radioactive fallout. (tr-auth)

14086 MEASUREMENT OF ACTIVITY CONCENTRATIONS IN WATER AND AIR. R. Neuwirth and S. Mueller. Mitteilungsbl. Strahlungsmessgeraete, No. 2, 3-6(Apr. 1960). (In German)

A review of fallout measurements in air and water in 1958 and 1959 and the measurement methods used is presented. (M.C.G.)

14087 THE WATER MONITOR FH 95. W. Buchner. Mitteilungsbl. Strahlungsmessgeraete, No. 2, 7-8(Apr. 1960). (In German)

Equipment for measuring radioactivity in water is described. A diagram and a picture are included. (M.C.G.)

14088 RADIOACTIVE FALLOUT. Monnerot-Dumaine. Presse Med., 71: 839-41(Mar. 30, 1963). (In French)

A general discussion of fallout is presented, especially regarding its origin and nature, its detection, prevention of contamination of water and food supplies, and decontamination of affected supplies. (BBB)

14089 DIFFUSION OF CESIUM-137 IN SOIL. V. M. Prokhorov and Tien-ying Chai. Radiokhimiya, 5: 639-42 (1963). (In Russian)

The distribution coefficient of Cs^{137} in humid soil is 20 to 250 fold as high as the distribution coefficient of Sr^{90} under identical conditions. The rate of Cs^{137} diffusion into light agrillaceous soils was abnormally high and under humid conditions practically identical to that of Sr^{90}. (R.V.J.)

14090 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME V, NUMBER 2. (Public Health Service, Washington, D. C.). Feb. 1964. 59p. $0.50(GPO).

Data are summarized on fallout radioactivity in samples of airborne particulates, precipitation, surface waters, and milk collected throughout the U. S. and Canada during Oct. 1963. Data are included from air sampling programs in Pan America and along the 80th meridian. Data are included on levels of radiation in the environs of Brookhaven National Lab. and the Dow Chemical Co. Rocky Flats Plant from July 1962 to July 1963. One low intermediate yield underground explosion was reported during Jan. 1964. Separate abstracts were prepared for 5 sections of this report. (C.H.)

For abstracts of individual sections see: 13436, 14146, 14147, 14148, and 14149.

14091 UMWELTRADIOAKTIVITAT UND STRAHLENBELASTUNG BERICHT III/62. (Environmental Radioactivity and Radiation Burden. 3rd Quarterly Report, 62). Bad Godesberg, Ger., Bundesminister für Wissenschaftliche Forschung, 1962. 285p. 8.00 DM.

The content of radioactive material in air, water, soil, and food, and the radiation burden to the population of the Federal Republic of Germany are reported for the fourth quarter of 1962. (M.C.G.)

14092 PROPORTIONAL SAMPLING FOR RADIONUCLIDES IN RIVER SYSTEM BELOW OAK RIDGE. M. A. Churchill (TVA, Chattanooga, Tenn.). 17p. (CONF-402-1)

From American Geophysical Union 43rd Annual Meeting, Washington, D. C., Apr. 1962.

The methods used and early results obtained in sampling the Clinch and Tennessee Rivers at several locations between Oak Ridge and a point (Chattanooga) some 120 river miles downstream are reported. The techniques used permitted not only determinations of concentrations of specific radionuclides, but also the proportions of the quantities released that, in the flowing water, reach various downstream locations. (P.C.H.)

Techniques and Equipment

14093 (NP-13645) SYLLABUS OF ON-SITE INSPECTION. Second Edition. (Stanford Research Inst., Menlo Park, Calif.). July 1963. Contract AF49(638)-1225. 181p.

The status of knowledge and the theoretical limits of capability of all those technical methods that might be used in on-site inspection are summarized. All technical methods that might be applicable to on-site inspection are listed, their operation described, their chief limitations and a general evaluation of their applicability presented, and promising lines of research that might either improve the method itself or its evaluation are indicated. Methods covered include: visual observation, aerial photography and

other imaging methods, local seismic monitoring, geochemical and radioactivity measurements for fully contained underground explosions, solid state effects, seismic exploration, seismic calibration, electrical geophysics, magnetic measurements, surface displacement surveys, surface geothermal measurements, gravity measurements, and neutrino detection. The applications of inspection techniques in specific environments, including drill holes and mines and for inspection of underwater explosions and underground explosions beneath a body of water, are discussed. (M.C.G.)

14094 GAMMA SPECTROMETRY AND ITS APPLICATION FOR GEOLOGICAL MEASUREMENTS. W. Klein. Mitteilungsbl. Strahlungsmessgeraete, No. 6, 3-7(Oct. 1961). (In German)

Gamma spectrometry is shown to offer a simple method for analysis of geological samples. The principles of such measurements are explained and results of investigations are discussed. (M.C.G.)

14095 AN EXAMPLE FOR THE MEASUREMENT OF RIVER WATER LOW ACTIVITIES WITH METHANE FLOW COUNTERS. L. Kranz and L. Weise. Mitteilungsbl. Strahlungsmessgeraete, No. 6, 8-9(Oct. 1961). (In German)

Monitoring radioactivity in river water using a proportional detector is discussed. The measuring arrangement is described. (M.C.G.)

14096 DATING OF OLD MORTARS BY THE CARBON-14 METHOD. J. Labeyrie and G. Delibrias (Centre des Faibles Radioactivités, Seine-et-Oise, France). Nature, 201: 742(Feb. 15, 1964).

Carbon dioxide trapped in mortars during preparation yields C^{14} that may be used for dating. Four samples from buildings of known ages were measured by this method, and the hypothesis was verified. Preliminary microscopic examinations are necessary to reveal Foraminifera that might add unknown quantities of ancient carbonates. (H.M.G.)

Thorium and Uranium Minerals

14097 LONG-TERM URANIUM RESERVES AND URANIUM SUPPLY. W. Mackenthun. At. Strom, 9: 101-5 (Dec. 1963). (In German)

The position of the uranium industry in the free world and its development up to 1980 are described. The uranium reserves already inventoried are reported, and the exploitation of these reserves is discussed on the basis of known production programs. The consumption of uranium between 1970 and 1980 is estimated. The method used for the calculation of these uranium needs is described. (J.S.R.)

14098 DAS URAN UND SEINE GESCHICHTE. (Uranium and Its History). Franz Kirchheimer. Stuttgart, E. Schweizerbart'sche Verlagsbuchhandlung, 1963. 379p. DM 51.40.

The history of uranium from the early times of the knowledge of its minerals to the discovery of radium in 1898 is reported. The rise of uranium to its present importance is also considered. Topics covered include: first notice of minerals of uranium; the discovery of uranium; the preparation of metallic uranium; the discovery of radioactivity and radium; the minerals of uranium and their occurrence in Africa, Asia, Australia, Europe, North America, and South America; and the uranium ores and their utilization until 1898. A bibliography on uranium occurrence covering literature from 1789 to 1898 with over 800 references is included. (M.C.G.)

HEALTH AND SAFETY

Refer also to abstracts 13486, 13487, 14011, 14196, 15604, and 15657.

14099 (AD-412431) DETERMINATION OF PARAMETERS FOR RADIOLOGICAL PREDICTION AND MONITORING SYSTEMS. P. Reimers, C. Diehm, B. Holz, H. Kurkjian, and D. Hatheway (Radio Corp. of America. Data Systems Center, Bethesda, Md.). June 1963. Contract OCD-OS-62-140. 210p.

Design concepts and parameters are presented for two radiological monitoring systems for civil defense. These are a shelter-based system, and an automatic system. Gamma radiation intensities up to 1000 r/hr can be monitored. Recommended spacing of sensors is based on computer simulation of accuracies obtainable with various sensor spacings. Various combinations of instrument error, fallout pattern, probability of instrument malfunction, and orientations of the sensor network were used in these simulations. Initial costs and annual operating costs are estimated. (auth)

14100 (AD-415614) SHELTER MEDICAL SUPPORT SYSTEM STUDY. FINAL REPORT OU-107. PART I. ANALYSIS OF EXTERNAL MEDICAL SUPPORT SYSTEM STRATEGIES. W. T. Herzog (Research Triangle Inst., Durham, N. C.). PART II. ILLNESS SPECTRUM AND PATIENT CASELOAD, DURHAM-ORANGE COUNTY, NORTH CAROLINA. Warner Wells and William James Cromartie (North Carolina. Univ., Chapel Hill). Aug. 31, 1963. Contract OCD-OS-62-271. 61p.

Part I. Various policies of allocating medical resources (manpower and material) in an area network of public fallout (PF) shelters during a post-nuclear emergency period of two weeks are reviewed. It is concluded that a policy of assigning medical resources to large shelters is superior to concentrating them in hospitals or treatment centers. The near optimal strategy requires dispersal of physicians in high PF shelters, because of their potential value in the post-shelter period. In fallout only environments, medical support of the population would place minimal demands on the transportation, shelter management, and warning systems. Demands on the communications system are likely to be excessive. Recommendations of additional research for medical planning are included. Part II. Background data essential for the measures of effectiveness used in Part I are presented. Treatment requirements and expected fatality (at various levels of medical care) of the hospital emergency room caseload in Durham-Orange Counties, N. C. are described. (auth)

14101 (AD-427995) IMPROVEMENT OF PROTECTION DATA BASE FOR DAMAGE ASSESSMENT AND DATA BASE ON SHELTER NEEDS. Final Report. Volume II. Philip McMullan, John Neblett, Edward Hill, Hale Sweeny, Philip McGill, and Rodney Sink (Research Triangle Inst., Durham, N. C.). Jan. 13, 1964. Contract OCD-OS-62-144. 103p.

Results are reported for five studies concerned with obtaining, compiling, or analyzing fallout shelter protection data. Subjects covered include: a review of the residential basement data which were obtained from the 1960 U. S. Census of Housing; an examination of electric power availability in the postattack period, with emphasis upon fallout protection in power plants; the preparation of a procedure for extracting summary distributions of overpressure, reference intensity, and fallout arrival time and relating these to numbers of people exposed, on the basis of data extracted from the Attack Environment III output tapes of the Jumbo III damage assessment system; the re-evaluation with National Fallout Shelter Survey (NFSS) data, of an analytical model for predicting fallout protection for people as a function of their distance from the center of a city; and a statistical analysis of NFSS data from Houston, Texas, and Durham, N. C., performed to determine distribution functions expressing their shelter characteristics. These analytical representations of NFSS data are applied, in an illustrative example, to optimal allocation of improvement dollars to ventilating below ground shelters to increase their capacity. (auth)

14102 (AD-428008) IMPROVEMENT OF PROTECTION DATA BASE FOR DAMAGE ASSESSMENT AND DATA BASE ON SHELTER NEEDS. Final Report. Volume I. Philip McMullan, John Neblett, Joseph Battle, Herbert Campbell, Quentin Ludgin, Philip McGill, Rodney Sink, and Arnold Weiss (Research Triangle Inst., Durham, N. C.). Jan. 13, 1964. Contract OCD-OS-62-144. 97p.

The procedures devised for using the National Fallout Shelter Survey (NFSS) data in damage-assessment systems and civil defense systems evaluation are reviewed. A procedure for using NFSS data in existing damage-assessment systems is devised, programmed for the UNIVAC 1105, and tested in the Jumbo III system of the National Resource Evaluation Center. Test results, using a single attack pattern and Phase 1 NFSS data, show significant fallout casualty reductions over previous estimates. Category 1 shelter (PF 20 to 39) contributes substantially to this reduction. The results also show fallout casualties to be quite sensitive to the movement-to-shelter assumption. Casualty results from a test assuming country-wide population mobility are significantly less than those obtained when movement is limited to within a standard location. A transportation problem formulation is used to simulate the movement of people to shelter within a city. The solution to the problem when so formulated allocates people to shelter in a manner to maximize survivors (or other objective functions). Tests over a range of fallout environments using this information show that the minimum fatality allocation to shelter is particularly sensitive to fallout build-up, movement through fallout, and shelter PF's. An equivalent residual dose (ERD) model which computes ERD in a time-varying radiation environment is programmed for the IBM 1620 and 7072. It has been found that the peak ERD after emergence may exceed the peak ERD in the initial shelter. The shelter allocation model and the peak ERD model form the basis for the Mainline Computer Program, a procedure for computing the survivors added by alternative CD system improvements. This program is currently being developed into a working tool for CD systems evaluation. (auth)

14103 (AHSB(S)R-63) A SPECIFICATION OF WOOD- AND CADMIUM-SHIELDED CLASS I PACKAGES PROPOSED FOR I.A.E.A. TRANSPORT REGULATIONS, 1963. F. Abbey and R. A. O'Sullivan (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, Risley, Lancs, England). 1963. 23p.

Changes in part of Annex II of the first regulations for safe transport of radioactive materials published in Safety Series No. 6 are proposed in which certain values are revised and the scope of the Annex is extended to include pack-

ages satisfying Class I requirements (safe in any arrangement under all foreseeable circumstances of transport) by the application of an advantageous combination of both mass and geometry restriction to the fissile content. The methods of calculation used are described and the sources of essential data are indicated. (auth)

14104 (CONF-277-6) THE U. S. ATOMIC ENERGY COMMISSION AND RADIOLOGICAL EMERGENCY ASSISTANCE. F. Raymond Zintz (Atomic Energy Commission, Washington, D. C.). [1963]. 7p.

From Symposium on Radiation Emergencies in Medicine, Research, and Industry, Chicago, Dec. 1963.

The AEC supports a nation-wide program of radiological emergency assistance to protect the health and safety of the public while effectuating the development, use, and control of nuclear energy under the provisions of the Atomic Energy Act of 1954 as amended. Radiological assistance is provided in emergencies involving radioactive materials through 8 regional offices that maintain a radiological emergency response capability available 24 hr a day to supplement the resources of contractors, military organizations, and state and local agencies. The organization and operation of the radiological assistance program is outlined. (C.H.)

14105 (EUR-489.f) SCHÉMA ANATOMO-PHYSIOLOGIQUE DU TRACTUS GASTRO-INTESTINAL, A PRENDRE EN CONSIDÉRATION POUR LE CALCUL DES NIVEAUX DE CONTAMINATION RADIOACTIVE. (Anatomo-physiological Scheme of the Gastrointestinal Tract, to be Taken in Account in Determining the Levels of Radioactive Contamination). Claudine Fabry (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). 1963. 26p.

Anatomical and physiological data of the gastrointestinal tract of adults and children were summarized in a standard schema, to be used in calculating the levels of radioactive contamination in the food chain. (auth)

14106 (HW-78956) A METHOD FOR BETA-GAMMA HAND AND SHOE COUNTING UNDER VARYING BACKGROUND CONDITIONS. W. G. Spear (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1963. Contract AT(45-1)-1350. 29p.

A method was developed for counting hands and shoes for beta-gamma emitting radionuclides under relatively high gamma background conditions. Operational conditions at many Hanford counter locations are such that the normal hand and shoe counter would be ineffective. This point of ineffective operation is usually reached when the gamma background exceeds 50 μr/hr. Under such conditions, the usual counter cannot reliably detect a 10 nanocurie radium D-E-F test source as required at Hanford. The Hanford developed prototype instrument for beta-gamma counting of hands, shoes, and clothing employs scintillation detectors and solid-state circuits. A method of automatically compensating for the effect of gamma background levels up to 1 mr/hr is employed. The automatic compensation or subtraction feature provides reliable detection of the test source over a background variation from the natural level of 15 or 20 μr/hr to the upper operational level of 1 mr/hr. The test source may be a point source or a source distributed on an approximate area of 25 in^2. A total of 10 background detection probes for hands, shoes, and background are employed along with one clothing contamination detector. (auth)

14107 (IDO-12032) HAZARDOUS MATERIALS FILTER MANUAL FOR THE NATIONAL REACTOR TESTING STATION. B. J. Held, G. Wehmann, D. R. Mousseau, R. D. Fletcher, and R. G. Anderson (Idaho Operations Office, AEC). Aug. 26, 1963. 34p.

This manual was prepared as a guide to the persons having a responsibility in a filter program. Included are filter specifications, selection, testing, inspection, handling, maintenance, filter box design, and field leak testing at NRTS. (D.L.C.)

14108 (MRL-397) TRAINING MANUAL FOR RADIATION MONITORING TEAMS. Vol. 21, No. 28. J. Richard Briggs (Naval Medical Research Lab., New London, Conn.). Dec. 15, 1962. 31p. (AD-401761)

Basic information and guidance are presented for the training of radiation-monitoring teams made up of candidates with little or no knowledge of atomic or nuclear radiation. As a practical approach to the subject of radiation biology, a brief review of the relevant mathematics and physics is presented. Familiar examples and situations are used to illustrate important aspects and procedures, and finally, specific action and details are set forth as a guide for team action. Radiation monitoring teams are of primary importance in the initial handling of any accident involving radioactive material. The training and skill acquired by such teams may well be the factor of control required in emergencies until more highly trained personnel are available. These teams add immeasurably to the ability of ships and other activities in coping with all phases of control of radioactive contamination, and also in supplementing work done by more highly skilled and trained personnel. (auth)

14109 (NP-13604) USDA RADIOLOGICAL MONITORING HANDBOOK. Agriculture Handbook No. 246. (Department of Agriculture. Agricultural Research Service, Beltsville, Md.). July 1963. 47p.

Procedures are described for the monitoring of radiological fallout on agricultural and forest lands; in water used for agricultural purposes, livestock, meat and poultry; and commodities stored or harvestable on farms and ranches. Radiological monitoring includes identifying radiation, measuring its intensity, interpreting radiological data, and helping to develop defense plans that will prevent or alleviate damage and injury from excessive radiation. It is pointed out that the levels of radiation associated with fallout from nuclear weapons testing are so low that civil defense instruments now available are unable to measure accurately the resulting degree of contamination. (C.H.)

14110 (NP-13688) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 1, No. 12. (Canada. Dept. of National Health and Welfare, Ottawa). Dec. 1963. 47p.

In English and French.

Current data from the various programs that are being carried out by the Radiation Protection Division are given. The most recent analytical results on the fallout monitoring program are included. A chart of the Division's programs is shown. In addition to the fallout analyses, data are presented from the programs on reactor environment monitoring, personnel dosimetry (film monitoring), isotope safety assessments and field investigations of radiation safety. (auth)

14111 (OAD-RM-106) LINCOLN SHELTER UTILIZATION STUDY. VOLUME II. A SHELTER ASSIGNMENT PROCEDURE. Angelo Gualtieri and Gordon F. Jensen (Stanford Research Inst., Menlo Park, Calif.). Apr. 1963. Contract OCS-OS-62-135. 90p. (AD-405930)

A step-by-step process of assigning the population of Lincoln, Nebraska, to fallout shelters is discussed. The

techniques developed can readily be applied to numerous cities having characteristics similar to those of Lincoln, Nebraska. Large census tract maps can be designed and used in assigning blocks of people to shelters. Methods of developing day and night-time populations data for any given city are described. A technique of putting the shelter assignment on data-processing cards for information retrieval is discussed. Methods of sorting punched cards into useful shelter assignment reports are presented. Considerable attention is given to demonstrating the numbers of people who would be sheltered under three separate warning times. Certain rules, based on the natural behavior of people, are developed as an aid in the assignment process. Estimates of cost and effort expended are provided as a guide to any civilian defense official who would desire to use the technique described therein. (auth)

14112 (ORNL-3547) NUCLEAR SAFETY PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1963. (Oak Ridge National Lab., Tenn.). Mar. 1964. Contract W-7405-eng-26. 92p.

Research is reported on fission product aerosols produced by overheated reactor fuels, release of fission products on in-pile melting of reactor fuels under transient, behavior of fission products released during in-pile destruction of reactor fuels, characterization and control of accident-released fission products, measurement and prediction of behavior of released fission products in reactor systems, and containment engineering. Studies of the Nuclear Safety Information Center are discussed. (M.C.G.)

14113 (RTD-TDR-63-3086) VULNERABILITY OF NUCLEAR WEAPON SYSTEMS TO FIRE — STUDIES OF BURNING EXPLOSIVES. Final Report. (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Dec. 1963. Contract AF29(601)-1959. 124p.

Analytical and experimental studies of the behavior of burning Composition B and PBX 9404 under various degrees of confinement are described. These studies were undertaken to determine the properties of the gas, the conductive heat transfer to the explosive, the radiant heat transfer to the surfaces of the high-explosive and chamber, and the heat evolved by the burning of the explosive. The work resulted in a theory that describes the burning of the explosives under unconfined and confined conditions, and the ensuing pressure buildup during the period the explosive remains intact and the reaction is limited to its surface. The results are in good agreement with experimental measurements of pressure, gas temperature, chamber temperature, and heat flux to meters in the gas stream. Beyond a pressure of about 1000 psia, the samples of Composition B cracked causing an abrupt decrease in the rate of pressure rise. The cause of these phenomena and the question of whether or not PBX 9404 cracks were not resolved. The results of this work may be used to predict the minimum order of explosion that may arise from a system that is exposed to heating. (auth)

14114 (SC-DR-316-63) PRELIMINARY EVALUATION OF EARTH TARGETS FOR USE IN IMPACT EFFECTS STUDIES. Louis Jean Thompson (New Mexico. Univ., Albuquerque) and John L. Colp (Sandia Corp., Albuquerque, N. Mex.). Mar. 1964. Contract [AT(29-1)-789]. 65p.

The Aerospace Nuclear Safety Program requires an independent assessment of the safety of all nuclear power supplies used in aerospace under all conditions from factory shipment through re-entry from space. The effects of impact against any point on the earth by a nuclear power supply or its components must be evaluated as part of this assessment. This report: (1) evaluates the fundamental mechanisms involved in soil impacts by cylindrical projectiles with velocities of 500 to 700 feet per second; (2) defines the problem of specifying impact targets which closely simulate various portions of the earth's surface; and (3) describes an analytical and experimental program intended to obtain the information needed to properly specify a simulated earth target for use in Aerospace Nuclear Safety impact tests. (auth)

14115 (TAC-OA-TM-121) RAPID ESTIMATION OF RESIDUAL RADIATION DOSAGE. S. R. Woods (Tactical Air Command, Langley AFB, Va.). Apr. 1963. 16p. (AD-401196)

A simple and rapid means is presented for estimating the total radiation dose one might expect to receive during exposure in an area contaminated by fission products. Curves are included for exposure periods of 2, 4, 8, 12, and 16 hr and for accumulated doses of 50, 100, and 200 rem. In addition to the curves covering particular exposure periods, a special curve is included for estimating the dose for any period of exposure between 1 and 1,000 hr after detonation. A nomogram is included for converting radiation intensity measured at a particular time after detonation to the reference dose rate at one hour after detonation. Typical problems and their solutions are given to familiarize the reader with the use of the nomogram and the curves. (C.H.)

14116 (TID-7677) EIGHTH AEC AIR CLEANING CONFERENCE, OAK RIDGE NATIONAL LABORATORY, OCTOBER 22-25, 1963. B. H. Kornegay, D. K. Jamison, and J. M. Morgan, Jr., eds. (Johns Hopkins Univ., Baltimore). Contract AT(30-1)-1477. 693p.

Thirty-one papers and 4 panel discussions presented at the Eighth AEC Air Cleaning Conference are given along with 16 supplementary papers. Separate abstracts were prepared for 33 of the papers. The remaining 13 were previously abstracted for NSA. (M.C.G.)

For abstracts of individual papers see: 13404, 13920, 13999, 14000, 14001, 14002, 14003, 14004, 14005, 14006, 14007, 14117, 14118, 14119, 14120, 14121, 14122, 14123, 14124, 14125, 14126, 14127, 14128, 14129, 14472, 14581, 14582, 15611, 15658, 15659, 14683, 15588, and 15597.

14117 (TID-7677(p.56-72)) SAFETY ASPECTS OF THE DESIGN OF FILTERED VENTILATION SYSTEMS. S. E. Smith, F. J. Hall, and W. E. Holmes (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England).

A number of safety aspects of the design of filtered ventilation systems for radioactive and toxic buildings were considered. These include theoretical and experimental assessments of the heat release from fires of various kinds in workrooms, fume cupboards, glove boxes, and extract systems, the use of spark and flame arrestors, the ignitability of dust deposits in extract systems and filters, and the cooling of hot gases in exhaust ducts. As a result of this work, it was possible to formulate principles which should be followed in the layout and design of such systems, in the future; existing systems were found not to require any serious modification apart from installation of glass paper filters. (auth)

14118 (TID-7677(p.102-24)) EXPERIENCE IN TRAPPING IODINE-131 AND OTHER FISSION PRODUCTS RELEASED FROM IRRADIATED AGR-TYPE FUEL ELEMENTS. D. A. Collins, R. Taylor, and W. D. Yuille (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Harwell, Berks, England).

I^{131} and other fission products were released from irradiated stainless steel-clad uranium dioxide under conditions relevant to potential accidents in the Advanced Gas-Cooled Reactor. Measurements were made of the penetration of I^{131}, Te^{132}, Cs^{137}, and Sr^{90}, released in the above manner, through a trapping system consisting of an absolute filter, followed by a 4-in. deep bed of charcoal and a final absolute filter, in series. No significant penetrations were observed except in the case of I^{131} in the form of alkyl iodides. Some small fraction of the iodine released from the irradiated fuel is in this form and investigations showed some conditions in which this form can be produced from iodine initially present in other forms. Experiments with macroscopic amounts of methyl iodide, representing the above form of iodine, showed that it is only delayed on activated charcoal at temperatures up to 100°C, but part of it can be permanently retained at 200°C. Oxidizing catalysts showed some promise of effectively retaining methyl iodide, but the presence of carbon monoxide interfered. (auth)

14119 (TID-7677(p.145-54)) FINAL REPORT OF ECONOMIC SURVEY OF AIR AND GAS CLEANING OPERATIONS WITHIN THE AEC. M. W. First and L. Silverman (Harvard Univ., Boston. School of Public Health).

A survey was made of AEC air cleaning costs. Data pertaining to cleanable industrial fabric filters, electrostatic precipitators, dry mechanical dust collectors, and scrubbers are summarized. (M.C.G.)

14120 (TID-7677(p.155-62)) CHARACTERIZATION OF GAS-BORNE FISSION PRODUCTS. W. E. Browning, Jr., R. D. Ackley, and M. D. Silverman (Oak Ridge National Lab., Tenn.).

Two methods for determining the form of radioactivity in gases were investigated. In the first method, diffusion coefficients for fine particles and for radioactive vapors such as iodine and its compounds were determined by measuring the distribution of radioactivity on the walls of a channel previously exposed to gas carrying radioactive materials and flowing under laminar conditions. This method was utilized in investigating the nature and behavior of volatile iodine compounds. These were observed to occur, in certain situations, in conjunction with the elemental form. Information on such compounds may be needed to properly design removal devices for radioiodine and to interpret deposition behavior. Composite diffusion tubes having, in the direction of flow, inner surfaces of silver, rubber, and, activated carbon showed the presence of two non-elemental species of iodine in addition to the elemental. The compound or compounds that were retained by a rubber surface had an indicated diffusion coefficient in air of around 0.05 cm^2/sec, and that retained by activated carbon, about 0.10 cm^2/sec. These results together with data obtained by other means provided clues as to the identity of the iodine compounds and further work is planned in order to identify them more explicitly. The second method for measurement of the characteristics of radioactive aerosols makes use of fibrous filters. This method measures aerosols in terms of their response to the processes of inertial impaction, interception, and diffusion by determining their distribution versus depth in fibrous filters under carefully controlled conditions. The velocity dependence of the slope of distribution curves on a semilog plot identifies the mechanism of filtration, and the magnitude of the slopes indicates the intensity of the filtering action and thus the character of the particles. Experiments where diffusion is the controlling mechanism were quantitatively treated and particle sizes in the 50 to 500 Å range determined by this technique compared favorably with those obtained from concentrations and flow data and electron photomicrographs. (auth)

14121 (TID-7677(p.177-88)) PERFORMANCE OF DIFFUSION BOARDS FOR RADIOACTIVE GASES AND PARTICULATES. L. Silverman (Harvard Univ., Boston. School of Public Health).

The development of a diffusion board to act as a reactor containment or confinement wall, so that all the material released to the atmosphere would be cleaned, is described. Fabrication of ceramic honeycomb diffusion boards and their evaluation are discussed. Their removal of 0.079μ particles was comparable to absolute filters. (M.C.G.)

14122 (TID-7677(p.222-34)) NEW AIR CLEANING ACTIVITIES AT ARGONNE NATIONAL LABORATORY. C. L. Cheever (Argonne National Lab., Ill.).

The emergency exhaust filter system for ANL's zero power reactor cells and efficiency tests on this system are described. The system was designed to handle high-temperature and high-pressure discharge from the cells. Exhaust air cleaning changes being made in the principal cave facility are also discussed. These changes will improve removal of radioiodine from the cave exhaust. (auth)

14123 (TID-7677(p.235-47)) THE HOLDUP EFFECT OF DOUBLE REACTOR-CONTAINMENT AND ITS INFLUENCE ON DOSE FROM AIRBORNE RADIOACTIVE MATERIALS. Truman D. Anderson (Oak Ridge National Lab., Tenn.).

The effectiveness of double-containment holdup in reducing environmental hazards associated with the release of radioactive materials after a reactor accident was evaluated. The containment model used was made up of 3 series–connected enclosures consisting of the reactor core and two containment structures. Leak-rate equations are given. Leak rate with step release from the core, relation between leak rate and dose, effects of double containment on dose, and application to the N.S. Savannah are discussed. (M.C.G.)

14124 (TID-7677(p.297-316)) FOAM SUPPRESSION OF RADIOACTIVE IODINE AND PARTICULATES. Robert E. Yoder and Leslie Silverman (Harvard Univ., Boston. School of Public Health).

Tests were made to evaluate the effects of high activity levels, steam, water, and general scale-up of previous laboratory studies on the efficiency of systems for foam supression of radioactive iodine and particulates. The experiments confirmed previous reports that other lauryl sulfate foams with sodium thiosulfate reactant can be used to decrease iodine concentration in a closed chamber. The I^{131} concentration reduction attributable to leakage, dilution, and wall adsorption was 70% of the initial concentration, 100 minutes after the iodine release. When foam was added to the system, the I^{131} concentration reduction was 90% with air recirculation and 92% with no air recirculation at 100 minutes. The rate of iodine concentration reduction was 1.15% of the initial concentration per minute without foam, and 4% per minute with foam and no recirculation. The presence of particulates altered the pattern of removal, which was far less rapid than if no aerosol was present. (M.C.G.)

14125 (TID-7677(p.317-30)) LIMITS OF SENSITIVITY IN THE MONITORING OF RADIOACTIVE GASES, WITH PARTICULAR REFERENCE TO KRYPTON 85. J. Shapiro, R. E. Yoder, and L. Silverman (Harvard Univ., Boston. School of Public Health).

Calculations of efficiencies of idealized ionization chambers and particle detectors for monitoring radioactive

gases are presented. Kr^{85} was used as the radioactive gas in the calculations and measurements. It is shown that for levels of the order of 10^{-7} μC/cc, a simple cylindrical G-M counter is adequate if a large volume can be viewed, and it is the simplest detector available. (M.C.G.)

14126 (TID-7677(p.419-24)) FILTER EFFICIENCY AND CLOGGING. J. Pradel, F. Billard, G. Madelaine, and J. Brion (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Fontenay-aux-Roses).

It is generally admitted that filter efficiency increases with clogging. Experiments, conducted with three kinds of aerosols showed that efficiency may decrease with clogging, especially when filtering oily aerosols. (auth)

14127 (TID-7677(p.508-21)) EFFECT OF PARTICLE AGGLOMERATION ON THE PENETRATION OF FILTERS UTILIZED WITH DOUBLE CONTAINMENT SYSTEMS. M. H. Fontana and W. E. Browning, Jr. (Oak Ridge National Lab., Tenn.).

The penetration of filter systems in dual-containment systems by fission products adsorbed on particulate matter was studied theoretically. A simplified model was analyzed in which the particulate matter was assumed to be pure iodine, and all particulates having diameters less than 0.3 μ were assumed to penetrate the filters. It was shown that agglomeration would occur rapidly enough so that the particles, even though initially much smaller, would reach a 0.3-μ size in a short time (<20 min for typical water-reactor systems). This time is directly proportional to the containment volume and inversely proportional to the power level. Assuming that the filter efficiency of the secondary containment sweep gas filtration system is zero for particles less than 0.3 μ, the fraction of the core activity released to the atmosphere during that time was calculated for some conditions of interest. For one reactor system treated, less than 10^{-6} of the iodine available would be released. It was shown that conditions existing during a reactor accident could not be as pessimistic as those of this model. (auth)

14128 (TID-7677(p.537-44)) ELECTROSTATIC PRECIPITATOR FOR TREATMENT OF DIRECT-CYCLE, AIR-COOLED REACTOR EFFLUENT. R. B. O'Brien (General Electric Co. Nuclear Materials and Propulsion Operation, Idaho Falls, Idaho).

Results of tests on a pilot plant electrostatic precipitator for removing fission products, both particulate and gaseous, from the high-volume, high-temperature air coolant discharged from a nuclear aircraft gas turbine engine are summarized. The addition of silver compounds to the airstream, upstream of the precipitator, substantially increased precipitator efficiency and also improved iodine removal. (M.C.G.)

14129 (TID-7677(p.646-52)) THE NUCLEAR SAFETY PILOT PLANT—CAPABILITIES AND EXPERIMENTAL PROGRAM. L. F. Parsly, Jr. (Oak Ridge National Lab., Tenn.).

The Nuclear Safety Pilot Plant is a facility for investigating the behavior of fission products released into a containment vessel as a result of a core meltdown accident. The plant includes a furnace for melting irradiated UO_2 fuel elements, a 1350-ft^3 model containment vessel, and various auxiliary equipment for containment simulation, for mocking-up techniques that would reduce the radioactivity concentration within the containment vessel, and for experiment evaluation. Fuel elements containing up to 1000 curies of activity may be melted under a variety of accident conditions, which would simulate those in various accidents. The initial experimental program directed toward the transport phenomena of iodine, and employing both stable and radioactive iodine, is described. (auth)

14130 (UR-640) A FEASIBILITY STUDY OF A NEW DEVICE TO MEASURE RADON IN THE BREATH. John B. Hursh (Rochester, N. Y. Univ. Atomic Energy Project). Feb. 24, 1964. Contract W-7401-eng-49. 21p. (CONF-104-53)

From International Atomic Energy Agency Symposium on Radiological Health and Safety in Nuclear Materials, Mining and Milling, Vienna, Aug. 1963.

A new device developed for measurement of thoron in the breath has been studied for its suitability to detect breath Rn. Calibration curves are presented which show that the counting rate versus time for a given Rn concentration is a function of gas flow rate. If the flow rate is held constant, the counting rate is directly proportional to Rn concentration at any given time after gas flow begins. If 1 pC/l Rn in air at standard conditions is passed through the detector at a rate of 7 l/min, the 20-min total net count is 570 counts which may be compared with a 20-min background count of 4 counts. It is concluded that the proposed system should be satisfactory to detect Ra burdens in man with a lower limit of about 0.01 μC. (auth)

14131 (Y-1401) Y-12 RADIATION SAFETY MANUAL. P. C. McRee, C. M. West, and J. D. McLendon, eds. (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). July 23, 1963. Contract W-7405-eng-26. 115p.

Health physics procedures are described. Personnel monitoring, process area monitoring and contamination control, plant-site and off-site monitoring and contamination control, special surveys, and calibration programs are discussed. The radiation safety emergency monitoring program and the industrial hygiene program are also described. (M.C.G.)

14132 (JPRS-23222) THE PROBLEM OF THE CONDITION OF THE CARDIOVASCULAR SYSTEM IN PEOPLE WORKING WITH RADIOACTIVE LUMINOUS COMPOUNDS. L. G. Tsenterova. Translated from Gigiena i Sanit., 28: No. 12, 42-6(1963). 7p. (OTS-64-21556)

Functional changes in cardiovascular regulatory mechanisms in individuals with a history of prolonged contact with luminous paints are reported. The paints contained radium, radiothorium, mesothorium salts, and mixtures of these. Results are reported from a survey on 176 persons from 20 to 40 yr of age, most of whom had worked with luminous paint for 5 yr or more. (C.H.)

14133 (JPRS-23284) HYGIENIC PROBLEMS IN THE RADIOACTIVE CONTAMINATION OF OUTER SPACE. Translated from Gigiena i Sanit., 28: No. 10, 3-7(1963). 6p. (OTS-64-21591)

The hazards of radioactive fallout from nuclear explosions in the atmosphere, underwater, and in outer space for plants, animals, and man are reviewed. The merits of the nuclear test ban treaty are discussed. (C.H.)

14134 DRAWING UP REGULATIONS CONCERNING IONIZING RADIATIONS. A. Lafontaine. Assoc. Belge Develop. Pacifique Energie At., Bull. Inform., 8: Nos. 45-46, 81-8(Oct. 1963). (In French)

The factors to be considered in drawing up regulations to ensure protection against radiation are discussed by a consideration of the dangers from radiation, the origin of radiation, and the principles of any protection standards. The recommendations and directives given by international organizations and the legal orders in force in Belgium are summarized. (J.S.R.)

14135 CRITICALITY. F. R. Farmer. Energie Nucl., 5: 573-80(Dec. 1963). (In French)

Conditions in which criticality accidents can happen in plants where large quantities of fissile substances (associated or not with neutron moderators or absorbers) are manipulated are reviewed and the measures in which knowledge on this problem can be applied to simple systems in order to conceive and develop plants with complete security were examined. An examination of accidents that occurred in chemical plants and of their causes led to the discussion of security rules and classifications proposed in function of the importance of criticality overpower as evaluated in fission numbers. Simple relations likely to help in plant waste disposal and in first-aid are suggested. (auth)

14136 EVALUATION OF A HOSPITAL DISASTER PLAN. Charles U. Letourneau (Misericordia Hospital, Milwaukee). Hosp. Management, 94: 44-6(Nov. 1962).

Plans prepared for this hospital to be used in civil defense and other emergencies are described. (BBB)

14137 A COMMUNITY PREPARES FOR DISASTERS. W. Leon Hisle (Berea Coll. Hospital, Berea, Ky.). Hosp. Management, 94: 47-9(Nov. 1962).

Hospital disaster plans and a list of items for emergency use in civil defense and other disasters are outlined. (BBB)

14138 STATUS OF RADIOACTIVE FALLOUT IN IOWA. Edmund G. Zimmerer (Dept. of Health, Des Moines, Iowa). J. Iowa State Med. Soc., 52: 523-4(Aug. 1962).

Sampling stations for air, the border rivers, and milk, as part of a national network, are located in Iowa. A station for sampling the radioactivity in the atmosphere is located at Iowa City, and is operated on a 7-day week basis by the State Hygienic Lab. In addition to the national networks, a program of monitoring is conducted by the State Hygienic Lab. as a state program. The data collected in the monitoring programs in Iowa indicate that, to date, the levels of radioactivity have not reached significant concentrations. The data also indicate that transient increases of radioactivity have been produced by weapons-testing activities, but that these concentrations return to a low range within a matter of days. Des Moines milk samples were routinely analyzed for Sr^{90}, Sr^{89}, I^{131}, and Ca. In addition, the State Hygienic Lab. made similar determinations on other Iowa milk supplies. In considering these isotopes, the Federal Radiation Council has assigned concentration values in $\mu\mu$C/day. Values differ for these isotopes. To date, the Sr concentrations have been low. Levels were established for I^{131} on the basis of the potential effect on the thyroid glands of young children. If applied to adults, these ranges are subject to upward revision. Soon after the U. S. testing program was suspended, the I^{131} levels fell to the nondetectable range. This determination was discontinued until the Russian testing program in 1961. The average I^{131} levels in the Des Moines milk supply were (as $\mu\mu$C/l): 210 October, 210 November, and 30 June 1961; and 10 January to April and 90 May 1962. Fallout from the Russian tests was not appreciable in Iowa until the period of September 19 to 22, 1961, when Hurricane Carla recirculated fallout through the midwest. (BBB)

14139 RADIOACTIVE FUEL—A "PACKAGING" PROBLEM. Lead, 27: No. 3, 2-3(1963).

Description of the size, strength, thermal properties, design, and fabrication factors of lead-stainless steel-carbon steel shipping containers for radioactive fuel elements is discussed. (Rev. Metal Lit., 21: No. 2, Feb. 1964)

14140 CASUALTIES FROM NUCLEAR WEAPONS. II. THE RADIOACTIVE FALLOUT. F. C. Pace and W. R. Waters (Dept. of National Health and Welfare, Ottawa). Med. Serv. J. (Can.), 19: 341-63(May 1963).

A survey of the origin, physical characteristics, and effects on man of fallout generated by thermonuclear weapon detonations indicates the following hazards to human populations surviving the initial phase of an attack: radiation injury from the flash-radiation will not be observed in surviving casualties; radioactive fallout will be the source of radiation injury among survivors; the overall hazard from fallout will be much more extensive in space than that from the immediate effects of blast and heat; fallout effects are subject to mitigation by simple means; the injuries caused by the fallout will be whole-body injury (the acute radiation syndrome) by highly-penetrating γ rays, skin injury by the less penetrating β particles, and internal contamination by radioactive metabolites; and the biological effects will probably occur in this time-order. Clinical and pathologic effects of radiations from these external and internal sources are described in detail. Factors affecting the development severity of the acute radiation syndrome which are discussed, include: the quantity of γ radiation to which the body is exposed; the time period over which the exposure occurs; the part or parts of the body exposed; the presence or absence of other injuries; adverse physiological states; and age. A model is presented representing a hypothetical attack on Canada from which fallout doses in parts of various provinces are calculated, and attempts are made to evaluate doses expected to be encountered by rescue and rehabilitation personnel. A recommended outline of therapy is given. Decontamination of individuals and handling of contaminated casualties are discussed. (BBB)

14141 A METHOD FOR ROOM AIR MONITORING IN WORK WITH RADIOACTIVE GASES, ESPECIALLY SOFT BETA EMITTERS. Mitteilungsbl. Strahlungsmessgeraete, No. 3, 11-13(Sept. 1960). (In German)

Radiation measuring equipment for monitoring the content of radioactive gas in room air is discussed. Construction and methods of operation are described. Sensitivities are discussed. (M.C.G.)

14142 HOW TO TAKE CARE OF PATIENTS RECEIVING RADIOACTIVE TREATMENTS. Frances Ginsberg (New England Center Hospital, Boston). Mod. Hosp., 99: 126(Nov. 1962).

In caring for patients treated with radioactive materials, nursing personnel should know not only how to begin care, but also how to continue it, and how to dispose safely and effectively of the active applicators and needles used. The radioactive patient in a private room with an appropriate radium sign on the door should have no unauthorized visitors. When the patient is brought to the room, a lead-lined carrier for the applicator is placed there with forceps for handling the applicator, if and when it is needed. If a radium applicator should fall out, it should be picked up immediately with the forceps and placed in the container. The radiologist should be notified, and all bed linens and dressings remain in the room until the radiologist has given clearance for removal. Nursing personnel should be rotated daily, and no one should remain with the patient longer than 10 min in each hour. Responsibility for the activities of all personnel entering and leaving the room should rest with the head nurse, and all unusual events should be reported. After removal of the active applicator by the radiologist it should be placed in a lead container with a quaternary ammonium compound as a germicide. The carrier then is immediately closed and, together with the instruments, taken directly to the radiation department, where they will be dismantled, cleaned, and stored. (BBB)

14143 FIXATION OF RADIOACTIVE STRONTIUM IN SOIL. Birte Gregers-Hansen (Danish Atomic Energy Commission, Research Establishment, Risø, Denmark). Nature, 201: 738-9(Feb. 15, 1964).

The influence of heat treatments on the extractability of Sr^{85} from soil was investigated in loamy and sandy soils. Addition of inorganic compounds alone or in combination with heat treatment was also examined. Results presented indicate that heat treatment, either alone or combined with the addition of dihydrogen phosphate, does reduce the strontium extractability from soils by one to two orders of magnitude. Advantages of the method for soil decontamination are discussed. (H.M.G.)

14144 PVC DECONTAMINATION TENT. Plastics (London), 28: 59(Sept. 1963).

As part of the work in connection with decontamination equipment, a PVC decontamination tent was developed. The unit consists simply of two rooms, a shower area and a suit disrobing area. (auth)

14145 THE POLLUTION OF THE WATERS OF RIVERS AND OCEANS BY RADIOACTIVE WASTES. Pierre Pizon. Presse Med., 70: 1901-4(Sept. 29, 1962). (In French)

The recommended max level for nonidentifiable isotopes for the general population is given by the International Commission on Radiological Protection as 10^{-4} μC/ml water; levels for important isotopes are tabulated. Discussion is given for the methods used for disposal of low activity wastes in rivers and oceans, and the rest as concentrates or solids in the oceans. The disposal of materials in rivers at Mol, Harwell, Chalk River, Marcoule, Fontenay-aux-Roses, and Saclay is discussed. One case is discussed for seas, that of Windscale and Calder Hall on the Irish Sea; the data indicate that more study is needed on waste disposal in such bodies of water. The disposal of radioactive wastes in the oceans requires first that samples be maintained at great depth for avoidance of transport by ocean currents; 19 such troughs deeper than 7000 m are known. Oceanographic studies indicate that at least some of these deep waters are not stagnant, but contain little salt and are highly oxygenated. It appears likely that long-lived samples can rise to upper layers of the oceans and contaminate life. Resistance of radioactive contents to currents and corrosion appears doubtful. The absorption of radioactive isotopes by living organisms is discussed, particularly by plankton from the Marshall Island tests and from the Mediterranean, and by fish and algae in the Irish Sea near Windscale. The strict regulations of the National Bureau of Standards Manual 58 appear quite justified from these studies. (BBB)

14146 EFFECT OF THE EVAPORATION AND POWDERING PROCESSES ON THE IODINE-131 CONTENT OF MILK. Allan E. Raymond (New York State Health Dept., Albany) and George W. Williams. Radiol. Health Data, 5: No. 2, 70-2(Feb. 1964).

One of the first countermeasures against I^{131} contamination of the environment recommended by the National Advisory Committee on Radiation is the placing of all young children, lactating mothers, and pregnant women on evaporated milk or powdered dry skim milk. This proposed countermeasure assumes an average transit time of at least 2 months for the milk to reach the consumer in order to allow for a decrease in I^{131} activity due to radioactive decay. Results are reported from a limited investigation of the I^{131} content in evaporated and powdered milk and the role played in the various processing steps on reduction of the I^{131} content in milk. Results indicate that no I^{131} was removed during the processing of evaporated milk, but some I^{131} was removed during the processing of powdered milk. (C.H.)

14147 STRONTIUM-90 AND CALCIUM IN UNITED STATES WHEAT (1962) AND MILLING PRODUCTS (1958-1962). Joseph Rivera (Health and Safety Lab., AEC). Radiol. Health Data, 5: No. 2, 72-4(Feb. 1964).

Data are reported on the Sr^{90} and Ca content of the 1962 wheat crop and milling products from 1958 through 1962. An appreciable reduction of Sr^{90} content in the 1962 crop over that of the 1961 crop was noted. Data are summarized on the average Sr^{90} content in wheat, soil, and fallout in the U. S. from 1958 through 1962. (C.H.)

14148 STRONTIUM-90 IN CANADIAN WHEAT, 1962. H. Taniguchi (Dept. of National Health and Welfare, Ottawa). Radiol. Health Data, 5: No. 2, 75-6(Feb. 1964).

Data are presented on the Sr^{90} content in Canadian wheat from the 1962 crop. (C.H.)

14149 CESIUM-137 AND POTASSIUM IN FINNISH LAPPS AND THEIR DIET. J. K. Miettinen (Univ. of Helsinki); A. Jokelainen, P. Roine, K. Liden, and Y. Naversten. Radiol. Health Data, 5: No. 2, 83-97(Feb. 1964).

Data are summarized from a field study of the content of Cs^{137} and K in the diets and bodies of 190 Lapps and other inhabitants of the Inari County in northern Finland carried out in Oct. 1961. The Cs^{137} content of the people was determined by whole-body counting. The diet of each individual was determined by interview. The relation of the Cs^{137} content in reindeer meat, fish, and milk to the Cs^{137} body burden of individuals is discussed. (C.H.)

14150 THE MEDICAL EVALUATION OF FITNESS FOR WORK REQUIRING EXPOSURE TO IONIZING RADIATIONS: CLINICAL-STATISTICAL CONSIDERATION OF 1983 CANDIDATES FOR EMPLOYMENT AT NUCLEAR CENTERS IN ITALY. Massimo Giubileo and Ernesto Strambi (Euratom, Ispra, Italy and Comitato Nazionale per l'Energia Nucleare, Casaccia, Italy). Rass. Med. Ind., 31: 536-49(July-Dec. 1962). (In Italian)

The criteria employed and the findings encountered during the course of certification of employees for the two Italian nuclear research installations at Ispra and Casaccia are described. Of 1983 prospective employees, 82% were men and over half in the 20- to 30-yr age group. Thirty percent were destined for professional lab work, 24% for office work, and 46% for other positions. They were submitted to chest radiography, electrocardiography, hematology, and urinalysis. Of the candidates examined, 87% were judged to be fit and 2.5% fit under certain restrictions as to the type of position to be held. The highest rate of rejection was in the 40- to 50-yr age group. Of the rejected applicants, 6.3% of the total number were submitted to reexamination. Of the total number, 4.2% were considered poor risks for exposure to ionizing radiation. The percentages of rejection according to various types of disease or abnormality was as follows: hematopoietic system 60%, genitourinary system 32%, cardiovascular system 10%, lungs (tuberculosis) 8%, and skin 4%. The most frequent specific causes of rejection were leukocytosis, leukopenia, and anemia. All candidates with total circulating leukocyte counts below 3500 or above 11000 were rejected or reexamined later; 6.2% of the applicants were disqualified on this basis. (BBB)

14151 MEDICAL SUPERVISION OF EMPLOYEES IN RADIATION INDUSTRY. PART I. INSTRUCTIONS AND FORMULAS. PART II. REPORT OF THE INTERNATIONAL ATOMIC ENERGY ORGANIZATION. Schriften-

reihe Bundesmin. Wiss. Forsch., Strahlenschutz (Munich), No. 24, 1-104(1963). (In German)

Basic principles for medical supervision for protection from injuries from radiation are presented. Radiation protection regulations and investigation procedures are listed. Principles and details developed by the International Atomic Energy Organization for medical supervision are discussed. (M.C.G.)

14152 THE RADIOLOGIST AND PRACTITIONER IN RELATION TO THE SUPPOSED HAZARDS OF X RAYS IN RADIODIAGNOSIS. Ch. M. Gros and F. Weill (Hospices Civiles, Strasbourg). Strasbourg Med., 13: 259-76(Apr. 1962). (In French)

Hiroshima and Nagasaki survivors, affected at a great distance from the source of radiation, are discussed as examples showing effects of single low-dose irradiation. Somatic effects are considered in animals and men and include shortened life-expectancy. The possibility of radiation-induced malignancies in radiologists, infants of irradiated mothers, and atomic bomb survivors is discussed. Discussion is provided of a survey of 1500 leukemia cases in children under 10 yr, 547 of which had received prenatal radiation or whose parents had received it prior to their conception, and of another study which traced 42 of 269 leukemia cases in children to prenatal examination, as opposed to only 24 in a control group; 43 of 278 children showing other malignancies had undergone prenatal x radiation, as compared with 21 in the control group. It is cited that many cases have been observed of secondary malignancies developing after radium therapy for primary tumors, especially in cases where the dose exceeded 180 r. From extrapolation of observations on atomic bomb survivors, it has been suggested that a 1-rad dose to a million persons would result in two additional cases of leukemia, but the actual number of cases reported does not bear this out. Genetic risks are also considered, especially experiments in Drosophila showing an increase from 0.13% to 3% in the mutation rate for 1000 r, with 40 to 60 r doubling the natural rate. For man, results are not conclusive, but it is estimated that 10 r/gonad would double the mutation rate and that a dose of 1 r would increase it by 0.25%. Somatic effects of small doses have not been conclusively established, but a more firm basis exists for genetic effect. It is concluded that, for small doses, a genetic effect has been proved experimentally on animals, and only by extrapolation on humans, and that radiologic examination is no more dangerous than other methods of diagnosis or than natural radiation itself. (BBB)

14153 INTRODUCTION TO RADIOLOGICAL HEALTH. Hanson Blatz. New York, McGraw-Hill Book Company, 1964. 324p. $12.75.

A sound foundation is provided for the relatively new responsibility of radiological health that must be assumed by workers trained or experienced in engineering, science, medicine, and public health. The material is suitable also as a basis of preliminary training for those entering the full-time professional field of health physics or radiological safety. Serious attention is focused on the importance of the various aspects of radiological health and the control of radiation exposures of both radiation workers and the general public. All possible sources of radiation are considered in the introduction and placed into perspective. In addition to the detailed discussion of radiation sources, characteristics of radiation, interaction of radiation with matter, biological effects of radiation, maximum permissible doses and concentrations, radiation detection and measurement, shielding, contamination control, radioactive waste disposal, the control of radiological hazards, legal aspects of radiation control, and guarding against and handling of accidents are covered. There is a step-by-step discussion of planning radiation programs and installations, evaluating radiation hazards in existing installations, and eliminating hazards where they are found to exist. A concise summary of current opinions and controversies on radioactive fallout from nuclear weapon tests is included. (H.M.G.)

14154 REGULATIONS ON THE SANITARY CONTROL OF IMPORTED EGG PRODUCTS AND FEEDING STUFFS IN THE FEDERAL REPUBLIC OF GERMANY. W. Schmidt-Lorenz (Bundesforschungsanstalt für Lebensmittelfrischhaltung, Karlsruhe, Ger.). p.69-70 of "Radiation Control of Salmonellae in Food and Feed Products." Vienna, International Atomic Energy Agency, 1963.

The federal law and the regulations of the different states of the Federal Republic of Germany concerning the sanitary control of imported egg products and feeding stuffs are reviewed. (auth)

14155 NUCLEAR SURVIVAL MANUAL. BOSDEC—THE CONCRETE CURTAIN. First Edition. James R. Fairlamb. Butler, N. J., Drexel Winslow & Farrington, 1963. 187p.

When advantages and disadvantages of fallout shelter access are weighed, it becomes apparent that protection in the event of nuclear attack is necessary for the maintenance of a free civilization. The purpose of this manual is to make available in one complete reference, facts upon which the decision to build, or not to build, a fallout shelter may be based. Written for the layman, it is intended as a guide for shelter construction. To allay fear of the unknown attention is given to what can be expected in a nuclear attack: immediate effects of the explosion; type of nuclear explosions; thermal radiation and resultant injuries; blast behavior; attack possibilities; and survival range. Presentation of basic principles of radiation and nuclear physics contributes to the understanding of radioactivity effects, detection, and dosimetry. Essentials for shelter survival are discussed in detail, and the Bomb Shelter in Depth (BOSDEC) is applied to shelter construction specifications and procedure. A glossary defines nuclear science terms pertaining to warfare. (H.M.G.)

14156 INSTRUKTSIYA PO RABOTE S RADIOAKTIVNYMI VESHCHESTVAMI V NAUCHNO-ISSLEDOVATEL'SKIKH UCHREZHDENIYAKH GOSSTROYA SSSR. (Instructions for Handling Radioactive Materials in Scientific Research and National Construction). Moscow, Publishing House of Literature on Construction, Architecture and Construction Materials, 1963. 106p.

Rules and regulations are given for handling radioactive sources and materials in construction and industry. Data are included on basic terminology, permissible radiation doses, shielding against γ radiation, and radioisotopes. (R.V.J.)

14157 THE FALLEN SKY: MEDICAL CONSEQUENCES OF THERMONUCLEAR WAR. Saul Aronow, ed. New York, Hill and Wang, 1963. 134p.

This is a series of articles based on a symposium appearing in the New Engl. J. Med., 266: (May 31, 1962); cf. NSA, 17: 1671-4 (BBB)

INSTRUMENTATION

General

Refer also to abstracts 14312 and 15447.

14158 (AD-415781) PROGRESS REPORT [ON RADIATION EFFECTS], AUGUST 1963. (Litton Industries, Woodland Hills, Calif.). Contract AF33(657)-10584. 6p.

The effects of radiation on the performance of gyro preamplifiers is investigated using the Sandia Pulsed Reactor. Results show that no permanent degradation occurred as a result of 12 burst exposures. (N.W.R.)

14159 (ANL-6769(p.31-3)) PORTABLE POWER SUPPLY FOR THE SHONKA ELECTROMETER. William Prepejchal and Paul L. Michaud (Argonne National Lab., Ill.).

Field measurements with a muscle-equivalent radiation meter necessitated the development of a compact battery-powered control unit for the Shonka Electrometer. The a-c power supply consists of a stable Wein Bridge Oscillator with both positive and negative voltage feedback. Appropriate amplifying and impedance matching stages drive a medium-power complementary pair terminating in a step-up transformer which supplied the required alternating voltage. A schematic diagram is given. (M.C.G.)

14160 (EURAEC-110) [EQUIPMENT FOR ELECTRO-ANALYTICAL APPLICATION]. Quarterly Report No. 2, October–December 1960. (Brussels. Université). Work Performed under United States–Euratom Joint Research and Development Program. 12p.

The theory, design, fabrication, operation, and development of a chronometric counting unit for various electro-analytical applications in the field of nuclear chemistry are described. The method consists in substituting for the cathode ray oscillograph an electronic assembly based on the use of triggers connected with electronic chronometers which apply the principle of impulse counters. This substitution makes it possible to improve considerably the intrinsic accuracy of the different electrochemical methods being examined, to speed up the analysis, and to extend the scope of possible applications. (N.W.R.)

14161 (MATT-167) MILLIMETER SINGLE-SIDE-BAND GENERATORS. W. P. Ernst and A. Skislak (Princeton Univ., N. J. Plasma Physics Lab.). Feb. 1963. Contract AT(30-1)-1238. 20p.

A simple system consisting of two crystal modulators, a hybrid ring, and an adjustable phase shifter is used to produce a single side band suppressed carrier signal. 35 and 70-gc systems have been constructed and tested. Carrier and unwanted side band suppression exceeds 20 db. Either side band may be selected by simply changing the phase of one modulation input by 180°. A phase analysis of the generator is presented. (auth)

14162 (NP-13607) MODULATION EN ÉNERGIE D'UN FAISCEAU D'ÉLECTRONS PAR UNE CAVITÉ HYPERFRÉQUENCE, EN VUE DE LA MESURE DES DURÉES DE VIE DE NIVEAUX EXCITÉS DANS LE DOMAINE DE LA PICOSECONDE (thèse). (Energy Modulation of an Electron Beam by a Hyperfrequency Cavity for the Measurement of the Lifetimes of Excited Levels in the Picosecond Region (thesis)). Maurice Berlioux (Lyon. Université). [1963]. 72p.

A preliminary study on the development of a device for the measurement of the lifetimes in the picosecond region is reported. The method proposed consists essentially of adjusting the phase corresponding to the instant of formation of an excited level and that corresponding to its de-excitation by emission of electromagnetic radiation on a hyperfrequency wave. The energy modulation and the detection of the instant of zero phase by spectrometry were the areas studied in this preliminary investigation. Beta spectrometry was possible with high resolution with junction detectors. The hyperfrequency modulation cavity with high shunt resistance was fabricated. The theoretical and experimental studies have shown that the determination of time intervals with a precision of 9.5×10^{-11} sec is possible. It thus appears possible to study levels with a lifetime of the order of 10^{-10} sec. (J.S.R.)

14163 (NP-13608) ANALYSE D'UN CONVERTISSEUR ANALOGIQUE DIGITAL (100 CANAUX—500 NANOSECONDES) (these). (Analysis of an Analog to Digital Converter (100 Channel—500 Nanoseconds) (thesis)). Roland Borchi (Lyon. Université). [1963]. 73p.

The principle of the MacMahon converter was used to develop a 100-channel converter with a maximum conversion time of 500 nsec. The principle is discussed in some detail before the functional parts of the converter are described. The converter developed is ten times faster than commercial ones. The same information can be obtained in $\frac{1}{10}$th of the time, and it can analyze the same phenomena with 10 times more points. (J.S.R.)

14164 (PWAC-422) THERMOCOUPLE DEVELOPMENT [FOR THE] LITHIUM-COOLED REACTOR EXPERIMENT. Salvatore Fanciullo (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Mar. 5, 1964. Contract AT(30-1)-2789. 158p.

A refractory metal thermocouple consisting of W–5 Re/W–26 Re grounded junction thermoelements and alumina insulation, and clad with a $\frac{1}{8}$-inch OD, Nb–1 Zr-to-type 316 stainless steel co-extruded sheath was selected to be the primary temperature sensor on the Lithium-Cooled Reactor Experiment (LCRE). The work described was done to develop this thermocouple and to gain experience in using it. Although the W–5 Re/W–26 Re thermocouple was selected for primary usage, other thermocouple combinations were also studied on a parallel effort in case the W–5 Re/W–26 Re combination could not be used. They were also studied for the other test-related purposes since many LCRE requirements did not warrant the use of tungsten rhenium thermocouples. The additional thermocouple combinations studied were Chromel/Alumel, W–3 Re/W–25 Re, molybdenum/niobium, and Mo/W–26 Re. Results are also reported of work performed to improve thermocouple quality and fabrication techniques. A complete set of Pratt & Whitney Aircraft-CANEL specifications for thermocouples and thermocouple extension wire is included. (auth)

14165 (TID-18592) HIGH TEMPERATURE PRECISION TORSION-EFFUSION APPARATUS. K. M. Myles (Argonne National Lab., Ill.). Jan. 17, 1963. Contract W-31-109-eng-38. 9p.

A high-temperature precision modification of the torsion-effusion apparatus for the measurement of vapor pressures is described. Temperatures as high as 1900°K were maintained in the apparatus at pressures of around 5×10^{-7} mm

Hg. Vapor pressures in the range 10^{-2} to 10^{-6} mm Hg can be determined with a precision of ±2%. (auth)

14166 (TID-20301) A TRANSISTORIZED EMISSION REGULATOR FOR ION GAUGE AND R.F. MASS SPECTROMETER TUBES. Norman C. Peterson and Irving W. Price (Brooklyn. Polytechnic Inst.). [nd]. Contract AT (30-1)-1715. 6p.

A circuit is described which was used for regulating the electron current in a Bayard-Alpert ionization gage and in a r-f mass spectrometer tube. Its operation and some of the results obtained are described. (D.L.C.)

14167 (JPRS-23408) HIGH-PRECISION NUCLEAR METER FOR MEASURING MAGNETIC FIELD STRENGTH. E. (Ye.) E. (Ye.) Bogatyrev. Translated from Tr. Vses. Nauchn.-Issled. Inst. Metrol., No. 67, 76-88(1962). 18p. (OTS-64-21660)

A meter, based on the NMR method, is described for measuring field strengths of 250 to 25000 oersteds with an error of 0.003–0.005%. The sources of measurement errors are considered, together with results of experiments on the meter. (auth)

14168 A TELEVISION SYSTEM FOR OBSERVATION IN RADIATION FIELDS. Dorin Poenaru and N. Vilcov (Institutul de Fizica Atomica, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 519-23(1963). (In Rumanian)

Television cameras represent a useful tool of radiation safety for work in radiation fields because they obviate the need for entry by the personnel. The Superorthicon picture tube was found to be especially suitable for work in areas with low light intensity as it allows a resolution of 625 lines to be obtained at an average illumination of 0.5 lux on the photocathode. The installation used consists of the camera and the monitoring system, interconnected by a 50-m long cable. The camera is provided with a Biotar 58/2 objective, but it has an interchangeable mount for other objectives. The resolution of the system is 300 lines for progressive and 625 for intermittent sweep at 50 cps. The video signal is amplified to obtain the desired contrast on the viewing screen. The input system includes a current stabilizer for focusing and correction circuits for the Superorthicon tube, voltage stabilizers for 150 and 300 v and the required rectifiers. The system has operated since May 1962 at the cyclotron laboratory to observe areas traversed by the accelerated-particle beams and helped to minimize personnel exposure in the target area. (TTT)

14169 FRAUNHOFER DIFFRACTION AT 0°K OF FIELD EMITTED ELECTRONS PASSING THROUGH AN INFINITE SLIT. Andrzej Czachor (Inst. for Nuclear Research, Polish Academy of Sciences, Swierk). Acta Physiol. Polon., 24: 477-83(Oct. 1963).

A general wave function for electrons being emitted under the influence of an electrostatic field is adapted to the special case of emission by a very thin slit of infinite length. Using this, the resolution of the field emission microscope is estimated. (auth)

14170 A HIGH-FREQUENCY ION SOURCE. Štefan Bederka. Jaderná Energie, 9: 385-90(Dec. 1963). (In Czech)

The design, properties, and operation of a high-frequency ion source built for a neutron generator and supplying 1.5 ma of deuterons are described. The source consumption of gaseous deuterium is 12.5 cm^3/hour. (auth)

14171 THE APPLICATION OF RADIATION RELAYS FOR FLUID LEVEL INDICATOR SYSTEMS. K. Irmer (Institute of Radioactive Isotopes Application, Pirna-Copitz, Ger.). Messen, Steuern, Regeln, 6: 532-3(Dec. 1963).

The principle and operation of radiation relays for fluid-level indicators is described. The system consists of a radiator and a detector and the switching steps depend on the rate of change of the level. Three different circuit arrangements are shown and their performance characteristics are analyzed; they are similar for all, except for special purpose features. There is a dead zone inherent in each. The sensitivity and stability were checked on experimental models. (OTS)

14172 PULSE-HEIGHT ANALYZERS. W. Klein. Mitteilungsbl. Strahlungsmessgeraete, No. 7, 3-11(Apr. 1962). (In German)

Uses of pulse-height analysis for determining energy distributions of nuclear radiation or for energy-selective measurements are discussed. The radiation detector gives pulses proportional in amplitude to the energy of the radiation. Grey-wedge analysis is considered. Single-channel analysis and many-channel analysis are described. Diagrams of equipment are included. (M.C.G.)

14173 THE CONTROLLING AND RADIATION-MEASURING SYSTEM OF A NEUTRON DIFFRACTOMETER. H. Faatz and W. Klein. Mitteilungsbl. Strahlungsmessgeraete, No. 9, 9-12(Feb. 1963). (In German)

The design of a neutron diffractometer is described. Two processes are used for electronic control of the mechanical motion. The radiation measuring system consists of two similar instruments, one for measuring the primary radiation intensity and the other for measuring the singly or many-fold scattered neutrons. BF_3 counters are used for detectors. (M.C.G.)

14174 THE BETA-GAMMA PHOTOMETER FH 411A. K. H. Waechter and L. Weise. Mitteilungsbl. Strahlungsmessgeraete, No. 10, 3-7(Sept. 1963). (In German)

A beta-gamma photometer was designed for quantitative analysis with the help of the absorption of radiation. The advantages of beta-gamma photometry are listed and compared with usual photometry. The operational principles of the photometer are discussed. (M.C.G.)

14175 TRIPLE PULSE GENERATOR. Ryszard Bayer (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nucleonika, 8: 573-6(1963). (In Polish)

The design of a triple pulse generator is described and shown in diagrams. Principles of operation are discussed. (M.C.G.)

14176 A SINGLE CHANNEL AMPLITUDE ANALYZER WITH A FIXED DELAY OF THE OUTPUT PULSE. Michal Nadachowski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 577-9(1963). (In Polish)

The design of an amplitude analyzer with a fixed delay of output pulse is described and a diagram shown. Principles of operation, components, and construction are discussed. (M.C.G.)

14177 MEASUREMENT OF HIGH TEMPERATURES UNDER IRRADIATION CONDITIONS. THE USE OF MOLYBDENUM–PLATINUM THERMOCOUPLES. F. A. Reichardt. Platinum Metals Rev., 7: 122-5(Oct. 1963).

Tests were made on Mo–Pt alloys for use as thermocouples. It was found that Mo–Pt was compatible with graphite and helium at high temperatures. It was concluded that Mo–Pt alloys are most promising materials for measuring temperatures up to about 1700°C under conditions of high neutron flux, provided only that the atmosphere is non-oxidizing. (P.C.H.)

14178 TWO VERSIONS OF A SLIDING BAR VACUUM LOCK. A. J. H. Boerboom, A. P. de Jongh, and J. Kistemaker (FOM-Lab. for Mass Separation, Amsterdam). Rev. Sci. Instr., 35: 301-2(Mar. 1964).

Two versions are described of a sliding bar vacuum lock for the introduction of solid samples into the ion source of a mass spectrometer. Sealing is obtained by three stage differential pumping without the use of gaskets. The first version, having a bar diameter of 25 mm, can be used up to 2-kv accelerating voltage. The second one, having a 50-mm diameter, is double-acting and can be used up to 15 kv. (auth)

14179 PULSED NUCLEAR RESONANCE APPARATUS. W. Gilbert Clark (Univ. of California, San Diego). Rev. Sci. Instr., 35: 316-33(Mar. 1964).

The description of a complete pulsed nuclear resonance spectrometer suitable for experiments in solids is given. Its major features are the ability to operate at any frequency between 2 and 30 Mc, an rf pulse output power of 5 kw over most of this range, a receiving system recovery time of 5 to 10 μsec at 10 Mc, a sensitivity usually limited by thermal noise in the receiver coil, use of phase coherent detection, the availability of a wide variety of pulse sequences, and good long and short term stability of the entire system. Brief instructions for operating the apparatus are included. A method of using the "boxcar" integrator to record directly the steady-state absorption or dispersion is explained. (auth)

14180 PULSE GENERATOR SYSTEM FOR FAST-REACTION EXPERIMENTS USING A TIME-OF-FLIGHT MASS SPECTROMETER. J. S. Riney and W. C. Gardiner, Jr. (Univ. of Texas, Austin). Rev. Sci. Instr., 35: 384-7(Mar. 1964).

A transistorized pulse generator system for chemical kinetics experiments with a time-of-flight mass spectrometer is described. (auth)

14181 METHODS OF ELIMINATING OFF-FOCUS X RAYS IN ROTATING-ANODE X-RAY TUBE. Koichiro Shiga and Motoshige Yoshida (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rev. Intern. Ed., No. 16, 41-8(1963).

An x-ray tube is described that features a shielding plate and a rotating anode to eliminate off-focus x rays. Increased resolution is obtained with a very simple collimator. (R.E.U.)

14182 PRODUCTION OF POLARIZED NEUTRONS WITH A HIGH DEGREE OF POLARIZATION. N. G. Baazov and A. G. Mandzhavidze. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 9: 191-9(1963). (In Russian)

Apparatus for producing polarized neutrons at a reactor is described. An attempt was made to produce neutron beams with a high degree of polarization at the reflection angles of the order of the critical angle for cobalt. The polarized beam with the intensity (95 ± 4)% at the angles of about 8 minutes was obtained. (auth)

14183 NUCLEAR MAGNETIC RESONANCE SPECTROMETER OF HIGH-RESOLVING POWER USED IN CENTRAL LABORATORY ON AUTOMATICS. A. N. Lyubimov, A. F. Varenik and E. I. Fedin. Zh. Strukt. Khim., 4: 919-23(Nov.-Dec. 1963). (In Russian)

Descriptions are given of an experimental nuclear magnetic resonance spectrometer with high-resolving power and standard frequency of 40 Mc that uses sideband techniques. The spectrometer's 900-kgauss, 200-mm magnet is equipped with a water cooling system. Tests showed that the magnetic field stabilizing system secures stable operations with a resolving power 10^{-8}. Spectrometer performance was checked with ethyl alcohol and ethyl benzene, and the obtained spectra are included. (R.V.J.)

14184 EXPERIMENTAL INVESTIGATION OF QUADRUPOLE LENSES WITH A ZERO AND NEGATIVE CHROMATIC ABERRATION. S. Ya. Yavor, A. D. Dymnikov, and L. P. Ovsyannikova (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 99-104(Jan. 1964). (In Russian)

Data are given on the optical strength of a quadrupole lens consisting of electrostatic and magnetic lenses. An achromatic quadrupole lens and a lens with negative chromatic aberration are developed. (R.V.J.)

14185 ELECTRON-OPTICAL PROPERTIES OF TWO-DIMENSIONAL ELECTRIC AND MAGNETIC FIELDS WITH A MEAN PLANE. S. Ya. Yavor and M. Siladi (Ioffe Inst. of Physics and Tech., Leningrad and Inst. of Technical Physics, Hungarian Academy of Sciences). Zh. Tekhn. Fiz., 34: 105-9(Jan. 1964). (In Russian)

A rigid integration was achieved by separating variables in equations for focusing two-dimensional fields with mean planes. The obtained equation was used for determining electron-optical field-properties, in particular, for analyzing cylindrical electrostatic lenses at oblique beam incidence. Examples are given for certain combined fields. (tr-auth)

14186 HIGH-VACUUM ION SOURCE. M. B. Pyt'eva, G. V. Spivak, and E. M. Dubinina (Moscow State Univ.). Zh. Tekhn. Fiz., 34: 142-5(Jan. 1964). (In Russian)

Descriptions are given of a high-vacuum source based on ion extraction from a high-density electron beam. An ion current of 80 μa was obtained with a residual gas pressure of 10^{-5} mm Hg and an extraction intensity of 400 v. Ionization is maintained by high-density electrons in a beam. (R.V.J.)

14187 L'ELECTRONIQUE DANS LES APPAREILS DE CONTROLE NUCLEAIRE. TOME 1. (Electronics in the Instruments of Nuclear Control. Vol. 1). Georges Nicolo. Paris, Editions Eyrolles, 1963. 521p.

This book on electronics in nuclear control devices has an essentially practical character and is devoted to circuits of devices used in reactor control. The first chapter reviews the minimum elements of nuclear physics necessary to comprehend the usages of nuclear electronics. The theoretical and experimental concepts to explain the operation and use of electronic controls are discussed in chapters on particle detectors and general circuits. The specific topics then discussed are compensation of the heat filament voltage variation, continuously stabilized voltage and current circuits, linear measurement, logarithmic measurement, use of semiconductors in linear and logarithmic measurement, and effects of radiation on materials. (J.S.R.)

14188 NOVEL SOURCES AND DETECTORS FOR MASS SPECTROSCOPIC ANALYSIS OF SOLIDS. L. F. Herzog, 34p. (CONF-229-3)

From Eastern Analytical Symposium, New York, Nov. 1962.

Mass spectrographs are described and discussed as to applications and limitations. Experience up to the present with the vacuum vibrator, crucible, ion bombardment, thermionic, field emission and laser sources, electron multiplier, photomultiplier and scintillation detectors, as well as some interesting accessory circuits such as the synchronous detector, intensity ratio measurement and the Resolving Power Multiplier, are reviewed. (P.C.H.)

14189 PRESSURIZED TRIGATRONS WITH A 10 KV–50 KV LOW JITTER OPERATING RANGE. George Goldenbaum (Univ. of Maryland, College Park) and Eduard Hintz. 25p. (CONF-13-12)

From American Physical Society 1963 Southwestern Meeting, Houston, Tex., Feb. 1963.

By using enclosed switches at high pressures and small electrode spacing the breakdown characteristics of asymmetric trigatrons have been further improved. The mechanical construction is simple and voltages up to 50 kv can be switched. At electrode distances from 3 to 5 mm and pressures between 15 and 75 psi both statistical and formative time lags are below 20 mμsec, even with the operating voltage as low as one third of the static breakdown voltage. The comparatively small breakdown voltage in the triggered case with the observed short delay times is caused by the increasing nonuniformity of the electric field when the trigger potential is raised, and by an intermittent corona between the trigger pin and the main electrode, which starts during the charging period. (auth)

14190 GAUGE CALIBRATION IN THE ULTRAHIGH VACUUM RANGE. W. D. Davis (General Electric Research Lab., Schenectady, N. Y.). 12p. (CONF-209-23)

From American Vacuum Society Meeting, Boston, Oct. 1963.

Problems connected with generating known pressures in the ultrahigh-vacuum range are studied. The response of some representative gages at these pressures is measured. The method used is based on the calculable reduction in pressure produced by molecular flow through orifices of known conductance. The standard pressure is measured with a McLeod gage. The results obtained for a Bayard-Alpert gage, a hot-cathode magnetron gage, and a mass spectrometer are described. It is concluded that reasonably accurate calibration of gages at pressures below 10^{-10} torr can be accomplished without undue difficulty and with fairly simple equipment. For calibration with active gases such as N_2, the exit conductance from the calibration region should be at least several l/sec in order to minimize errors due to adsorption at the walls. (auth)

14191 IMPROVEMENTS IN OR RELATING TO ELECTRIC ARC DISCHARGE APPARATUS AND TO CIRCUIT ARRANGEMENTS INCLUDING SUCH APPARATUS. John Hubert Holliday (to General Electric Co., Ltd.). British Patent 947,880. Jan. 29, 1964. Filed Jan. 18, 1961.

An electric arc discharge apparatus is described that features coaxial arrangement of two anodes and a cathode of thin-film liquid metal. The cathode is mounted within a vacuum envelope to maintain the vapor pressure such that a vacuum gap exists between the anodes and the cathodes. A switching device is provided for cyclic operation of charge-discharge between the two anodes and the cathode. (R.E.U.)

14192 IMPROVEMENTS IN OR RELATING TO HUMIDITY DETERMINATION. Pierre Mangnier (to Commissariat a l'Energie Atomique). British Patent 951,291. Mar. 4, 1964. Priority date June 1, 1961, France.

A method and apparatus is described for determining the water-vapor content in a gas. The sample of gas is divided and passed into two analytical cells of an infrared absorption analyzer. A reagent acts with one of the samples to reduce the water to hydrogen, which is then analyzed by the second cell of the infrared absorption analyzer. The difference in absorption is then found for the two cells. (R.E.U.)

14193 A METHOD OF MEASURING THE INTENSITY OF A MAGNETIC FIELD. G. B. Bogdanov. Russian Patent 152,023. Jan. 20, 1962.

A ferromagnetic resonance method of measuring the intensity of a magnetic field is described. A ferrite thermistor connected to a d-c source and enclosed by a high-frequency waveguide coupled with an adjustable-frequency generator is used. It differs in that to increase the accuracy of the measurement, the thermistor is introduced into the magnetic field to be measured and the frequency of the generator is varied until it coincides with the resonance frequency of the thermistor. The value of the magnetic field intensity is determined from the variation of the thermistor's resonance frequency. (OTS)

Radiation Detection

Refer also to abstracts 13390, 13445, 13854, 14099, 14130, 14839, 15478, and 15612.

14194 (AD-412337) PIEZOELECTRIC CHARGER, CD V-751X. Final Report. R. Lehman and John Stirnkorb (Bendix Corp., Cincinnati). July 9, 1963. Contract OCD-OS-62-83. 69p.

The design, development, and fabrication of a radiological dosimeter charger, which uses piezoelectric ceramic crystals to generate the electric energy and a lens system for external ambient light only, is described. This charger, designated OCD Item No. CD V-751X, was developed as a possible replacement for the transistorized charger, OCD Item No. CD V-750, but requires no batteries; therefore, it has long shelf life. The effects of static stress on the piezoelectric properties of different ceramic materials were studied and basic formulas derived. Studies showed that the charge generated by the application of force to the piezoelectric material was directly proportional to force and to the material constant but was not dependent on the size. The material constants varied with stress, however, particularly at high stress values, so the size and shape affects the charge output indirectly. The charger is capable of using either natural sunlight or concentrated sources of light such as room light fixtures, flashlights, or candles. All performance and environmental test requirements were passed on the prototype chargers except that for humidity. Modifications to the prototypes are suggested that should correct this humidity problem. (auth)

14195 (AE-132) A NEUTRON REM COUNTER. I. O. Andersson and J. Braun (Aktiebolaget Atomenergi, Stockholm). Jan. 1964. 22p.

A neutron detector is described which measures the neutron dose rate in rem/h independently of the energy of the neutrons from thermal to 15 Mev. The detector consists of a BF_3 proportional counter surrounded by a shield made of polyethylene and boron plastic that gives the appropriate amount of moderation and absorption to the impinging neutrons to obtain rem response. Two different versions were developed. One model can utilize standard BF counters and is suitable for use in installed monitors around reactors and accelerators and the other model is specially designed for use in a portable survey instrument. The neutron rem counter for portable instruments has a sensitivity of 2.4 cps/mrem/h and is essentially nondirectional in response. With correct bias setting the counter is insensitive to gamma exposure up to 200 r/h from Co^{60}. (auth)

14196 (AEEW-M-335) THE RESPONSE OF SOME HEALTH PHYSICS INSTRUMENTS TO SODIUM-24 AND

CHLORINE-38 ACTIVITIES IN POLYTHENE MAN-PHANTOMS AND THE HUMAN BODY. C. O. Peabody (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Dec. 1963. 19p.

Measurements were made of the response of five commonly used health physics instruments when held near polythene man-phantoms filled with aqueous solutions containing sodium-24 and chlorine-38. The ratios of the whole-body chlorine-38 and sodium-24 activities are calculated for various periods of accidental human irradiation by neutrons. These ratios and the phantom results are used to estimate the response of the five instruments when held near the human body at various times after irradiation. Relative contributions of the chlorine-38 and sodium-24 to the instrument indications are listed. The tabulated data enable the instrument readings to be converted to whole-body sodium-24 activity at the time of irradiation. This may be used as a quick estimate of the degree of neutron irradiation. (auth)

14197 (ANL-6769(p.40-54)) A METHOD OF COMPENSATION FOR INSTRUMENTAL INSTABILITY IN A MULTICHANNEL GAMMA-RAY SPECTROMETER. Robert M. Parr (Argonne National Lab., Ill.).

A method for compensating instrument drift in multichannel gamma spectrometry by employing a separate reference source is described. This special source is counted either just before or just after the experimental source whose spectrum is to be analyzed. The reference spectrum is then compared with one accumulated during the initial calibration of the spectrometer, and by an iterative process, the net changes in gain and zero-energy intercept since that time are calculated. The data that constitute the experimental spectrum are then transformed by a computer program which shifts and stretches the experimental spectrum so as to compensate for the instrumental changes. The iterative method is described and evaluated and the equations for transforming spectra so as to compensate for these instrumental variations are developed. As an example of the applications of this procedure results of a preliminary investigation of the long-term stability of a spectrometer are presented. (M.C.G.)

14198 (AWRE-NR/A-1/59) A STUDY OF THE NEUTRON LONG COUNTER. M. H. McTaggart (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Jan. 1960. Reprinted, Sept. 1961. 24p.

A long neutron counter based on the Hanson and McKibben design was built. Its response is constant within 4% over a wide range of neutron energies. The effect of varying the geometry of the paraffin wax cylinder that forms the basis of the counter was investigated. It is found that the uniformity of its response to neutrons within a limited range of energies can be improved by inserting an absorbing sleeve around the BF_3 counter tube. (auth)

14199 (BNL-7805) ILLUMINATION OF 80" CHAMBER. F. Anderson (Brookhaven National Lab., Upton, N. Y.). Sept. 29, 1960. Contract [AT(30-2)-Gen-16]. 12p.

An estimate is made of the illumination required for the 80-in. bubble chamber, based on the absolute sensitivity of the film. The required intensity is estimated to be 23.4 lumen-sec/ft^2, and the aperture size for use with the flash tube is calculated to be 145 cm^2. The results are compared with these obtained from 72- and 20-inch chambers. (D.L.C.)

14200 (BNL-7806) ILLUMINATION OF 80" CHAMBER. H. L. Kraybill (Brookhaven National Lab., Upton, N. Y.). May 16, 1960. Contract [AT(30-2)-Gen-16]. 5p. (Handwritten MS Copy).

The needed illumination intensity is estimated from the 20-in. and 72-in. chambers to be 50 and 160 lumen-sec/ft^2, respectively. Possible source distributions are considered. With an intensity of 100 lumen-sec/ft^2 and a source brightness of 100 lumen-sec/ster. cm^2, the aperture is calculated to have a diameter of 8.6 cm. (D.L.C.)

14201 (BNL-7807) RETRODIRECTORS [FOR] 80" CHAMBER. H. L. Kraybill (Brookhaven National Lab., Upton, N. Y.). Feb. 16, 1960. Contract [AT(30-2)-Gen-16]. 13p. (Handwritten MS Copy).

The principles of the coathanger (retrodirector) are described. The zero-order design of a coathanger is derived. The error caused by the use of circular cross sections is estimated. The case of aplanatic refracting surfaces is considered. Allowable errors and tolerances are described in some detail. Spacing between coathangers is considered. (D.L.C.)

14202 (CEA-2299) ÉTUDE AU MOYEN DE CIRCUITS ÉLECTRONIQUES DE CERTAINES FLUCTUATIONS ALEATOIRES DANS LES MESURES DE RADIOACTIVITÉ À BAS NIVEAU. (Study of Certain Random Variations in the Measurement of Low-Level Radioactivities by Means of Electric Circuits). Djamchid Moghimi (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 68p.

Thesis submitted to Université, Paris.

An attempt is made to find a control method that ensures that there is really a statistical distribution of pulses during the measurement of very low activities. The use of a method based on the distribution of time intervals is examined first, as well as the graphical representation to which it leads. The second method is a study of the distribution of the number of pulses in a given time interval. It makes it possible to use two tests for verifying Gauss' law: Henry's graphical test and the κ^2 mathematical test. The electronic devices necessary for these tests were built; they made it possible to study the fluctuations in an installation for measuring the natural activity of carbon. (auth)

14203 (CEA-2356) DETECTEUR A SCINTILLATION POUR LA DOSIMETRIE D'EMETTEURS BETA INCONNUS DEPOSES SUR FILTRE DE GRANDE SURFACE. (Scintillation Detector for Measuring Unknown β Emitters Deposited on Large-Surface Filters). G. Soudain, J. Cercy, and B. Geoffre (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 31p.

An apparatus is described for direct counting, using a plastic scintillator, of unknown emitters occurring in atmospheric samples collected on large-surface filters (10 cm diameter). The quality of the apparatus depends largely on the uniformity of the photocathode in the photomultiplier used. The counter which was built had a counting efficiency for a 10 cm diameter source of 30% for S^{35}, 88% for P^{32}, 45% for unknown emitters and a background noise of 56 cpm. (auth)

14204 (CEA-2362) PRODUCTION D'UN CHAMP MAGNETIQUE DE 1 600 000 At/m DANS UN MILIEU NON MAGNETIQUE DONT LE VOLUME EST 0.5 DECIMETRE CUBE. ENROULEMENT REFROIDI A L'HYDROGENE LIQUIDE. (Production of a Magnetic Field of 1 600 000 At/m in a Non-magnetic Region of Volume 0.5 Cubic Decimeters by a Coil Cooled by Liquid Hydrogen). Paul Garin (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 186p.

Thesis submitted to Conservatoire National des Arts et Metiérs, Paris.

Cryogenic coils for producing very strong magnetic fields for liquid hydrogen bubble chambers were studied. The resistance of pure metals at low temperatures, the gain in power, thermal insulation, and suitable conductors and power supplies were considered. Two copper coils cooled in a liquid hydrogen bath were constructed and tested. The results indicate that coils capable of providing the desired fields present no great difficulties. (D.C.W.)

14205 (CONF-187-86) DEVELOPMENT AND EVALUATION OF LARGE VOLUME SCINTILLATION DETECTORS AND THEIR APPLICATION TO RADIOISOTOPE PROCESS CONTROL. J. Kent Perry (Colorado School of Mines Research Foundation, Inc., Golden). [1962]. Contract AT(29-2)-1355. 13p.

From American Nuclear Society Meeting, New York, Nov. 1963.

Large-volume scintillation detectors are being developed for radioisotope control of unit processes. In the development work, mirror-finished aluminum foil reflectors were better than diffuse reflectors, argon flushing to remove dissolved oxygen from liquid scintillators improves the pulse amplitude, and liquid scintillators are superior to plastics. Dimethyl POPOP was found to be an excellent primary solute; optimum concentration is 2.5 g/l in toluene with argon flushing and no secondary solute. A test loop was constructed for testing the detectors in process control applications. Among the systems being tested are one using a solid-state magnetic comparator-control relay and an inexpensive solenoid valve as the final control element, at ~25% of the cost of a conventional system. (D.L.C.)

14206 (CONF-346-11) INSTRUMENTATION FOR FISSION FRAGMENT ENERGY CORRELATION EXPERIMENTS. C. W. Williams, H. W. Schmitt, F. J. Walter, and J. H. Neiler (Oak Ridge National Lab., Tenn.). [1963]. Contract W-7405-eng-26. 19p.

From International Conference on Nuclear Physics with Reactor Neutrons, Argonne, Ill., Oct. 1963.

Experiments were performed in which the kinetic energies of correlated fragment pairs from thermal- and resonance-neutron-induced fission were measured. In addition, a three-parameter ternary fission experiment was performed in which the energies of correlated fragments were measured in coincidence with the energy of a third emitted particle, usually a long-range alpha particle. The detectors were large-area silicon surface barrier detectors. The instrumentation associated with these experiments is discussed in detail. The complete system is described, with attention given to the problems of background reduction (fast-coincidence requirements), stability, linearity, and resolution. Particular attention is given to the reduction of spectrum distortion by pile-up pulses (alpha-on-fission pile-up within the amplifier resolving time). Methods and limitations of pile-up detection are discussed. A new method for inspection and removal of pile-up pulses is described. (auth)

14207 (CONF-354-4) EXPERIMENTS WITH HEAVY IONS. C. D. Moak (Oak Ridge National Lab., Tenn.). [1963]. Contract [W-7405-eng-26]. 13p.

From Accelerator Conference, Boston, Nov. 1963.

Several difficulties involved in accelerating heavy ions in a tandem Van de Graaff are discussed, and experiments with Br and I ions to determine the response of silicon detectors to fission fragments are described. The pulse-height spectra of the ions are given, and the stopping cross section for I ions in Au, Ni, Al, and C at 20–120 Mev are plotted. (C.E.S.)

14208 (GNE/Phys/63-9) FEASIBILITY OF CADMIUM SULFIDE FOR SOLID STATE DETECTOR APPLICATION (thesis). Kenneth Allen Gale (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Aug. 1963. 76p. (AD-418516)

Solid state radiation detectors were constructed using CdS crystal platelets. The detectors were tested using both alpha and photon irradiation. Attempts to measure the lifetimes of the holes and electrons with alpha and photon irradiation and to measure the energy of the trap levels for the electrons failed for various reasons. The only quantitative result secured was a value of 2.48×10^{-6} cm^2/volt for the mobility-lifetime product of electrons and a value of 5.06 ev/ion pair for the average energy required to produce an ion pair. Other qualitative features such as the trapping of carriers and the formation of a plasma in the detector were observed. (auth)

14209 (JINR-P-1468) SKHEMA OBRABOTKI TREKOV V PUZYM'KOVOI KAMERE, SFOTOGRAFIROVANVYKH DVUKHOB'EKTIRNOI STEREOGOLOVKOI. (A Scheme for Analyzing the Tracks Taken with Two Cameras in a Bubble Chamber). V. F. Vishnevskii, Yuan-tsai Tu, A. F. Lik'yantsev, et al. (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy and Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1963. 13p.

Symmetrical formulas are used to calculate the spatial coordinates, independently of the y-displacement. Corrections for the film deformation and for errors due to optical misalignment are introduced. A technique for determining the spatial characteristics of the track by minimizing a functional construction of quantities taken in the plane of the left and right pictures is also suggested. Criteria for selecting correct measurements are developed, and computer storage and analysis of the measurements are considered. (auth)

14210 (JINR-P-1498) ISSLEDOVANIE KHARAKTERISTIK RAZRYADIYKH KAMER NAPOLNENNYKH NEONOM S RAZILICHNYMI DOBAVKAMI. (The Investigation of the Characteristics of Discharge Chambers Filled with Neon With Different Admixtures). I. I. Gromova, V. I. Nikanorov, G. Peter, and A. F. Pisarev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 38p.

The results are given of investigating the parameters of discharge chambers (the gap between the electrodes is 7 cm) when filled with neon with admixtures of Ar, H_2O, C_2H_5OH, CH_4, and CCl_4. It is shown that the CH_4 admixture of 0.1% introduced into the chamber leads to the decrease of the memory time from 16 to 1 μs, and the use of 3×10^{-6}% CCl_4 – from 16 to 1.6 μs. The use of H_2O and C_2H_5OH as admixtures does not improve time characteristics of chambers. (auth)

14211 (JINR-P-1400) KAMERA S TONKIMI ELEKTRODAMI I IZUCHENIE POLOZHENIYA TOCHKI SPRYAMLENIYA ISKRY. (A Spark Chamber With Thin Electrodes and a Study of the Position of the Alignment Point). F. Legar, V. I. Nikanorov, G. Peter, and A. F. Pisarev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 13p.

A technique for making the foil electrodes with two-sided working surface for spark chambers is described. Some characteristics of spark chambers with thin electrodes are given. The variation of the distance from the negative electrode to the alignment point of a spark with

the energy of the detected particles and the angle of their passage through the chamber was studied. It is shown that with the increasing initial density of the gas ionization in the chamber the Townsend coefficient a becomes greater due to the charge interaction of avalanches. (auth)

14212 (JINR-P-1516) DEISTVIE PROTONOV VYSOKOI ENERGII NA POLUPROVODNIKOVYE DETEKTORY YADERNYKH IZLUCHENII. (Effect of High Energy Protons on Semiconductor Detectors of Nuclear Radiations). L. S. Brykina, B. M. Golovin, A. P. Landsman, B. P. Osipenko, and O. P. Fedoseeva (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 11p.

The effect of high-energy protons on silicon surface barrier detectors was studied experimentally. The dependence of some parameters of these detectors on the duration of their presence in the radiation belts was estimated theoretically. (auth)

14213 (JINR-P-1526) KREMNIEVYI SPEKTROMETRICHESKII SCHETCHIK KAK LINEINYI DETEKTOR KOROTKIKH SVETOVYKH SIGNALOV. (A Silicon Spectrometer Counter as a Linear Detector of Short Light Signals). Yu. K. Akimov, A. I. Kalinin, and A. I. Sidorov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 10p.

The amplitude–time characteristics of the pulses arising in lithium-drifted surface barrier silicon p–i–n junctions due to light flashes several tenths of a microsecond long are described. A method of determining the spark coordinates using such detectors is considered. (auth)

14214 (LNF-63/65) UN POSSIBILE METODO PER LA DISCRIMINAZIONE DI EVENTI SPURI IN CAMERA A SCINTILLE — RISULTATI PRELIMINARI. (A Possible Method for the Discrimination of Spurious Events in Scintillation Chambers — Preliminary Results). Note No. 215. R. Habel and T. Letardi (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). Oct. 30, 1963. 4p.

In some studies with scintillation chambers, the problem of discriminating between the events generated by one or more ionizing particles and a spontaneous shower between the gaps of the chamber is presented. One element of difference between the two events is the delay of the spurious scintillation with respect to that produced by passage of a particle. The use of a fast shutter whose open time is of the order of the delay would provide a possible method for the discrimination between true and spurious events. The experimental apparatus used and the types of measurements made to determine if such a shutter arrangement would be feasible are described. (J.S.R.)

14215 (NP-13641) FAST NEUTRON TIME-OF-FLIGHT SYSTEM FOR USE WITH ISSP CYCLOTRON. Shinsaku Kobayashi, Hajime Ohnuma, Akira Uchida, Minoru Imaizumi, and Akira Mikuni (Tokyo Univ. Inst. for Solid State Physics). Sept. 1963. 25p.

During reconstruction of the 16-in. cyclotron, modifications were made to permit fast neutron experiments. The time-of-flight method was adopted as an energy analyzer for the fast neutrons. The time-of-flight system is described, together with the reduction of the repetition frequency of the bunched beam. Plastic scintillators are used for neutron detection. A proton beam with a peak current of 400 μamp is obtained with a duration of 2 nsec (natural bunching) and a reduced repetition frequency of 3 Mc at the neutron-producing target. The overall time resolution of the system is about 4 nsec for 1-Mev neutrons. (D.C.W.)

14216 (NP-13702) NEITRONNYI SPEKTROMETR PO VREMENI PROLETA NA BAZE LINEINOGO USKORITELYA ELEKTRONOV IAE. (A Neutron Transit-Time Spectrometer Based on the Linear Electron Accelerator of the IAE). Yu. V. Adamchuk, S. S. Moskalev, and G. V. Murodyan (Akademiya Nauk S.S.S.R. Ordena Lenina Institut Atomnoi Energii). 1963. 35p.

A time-of-flight neutron spectrometer for measuring neutron total cross sections in the energy range 0.7 ev to 50 kev is described. A pulsed beam of neutrons from the linear electron accelerator is used. The flight distance is 108 m, and the resolution is 0.005 μsec/m. A brief description is given of the detector and spectrometer. The experimental procedure for determining the resolution function is described. The control and calibration methods are also outlined. (tr-auth)

14217 (RISO-69) PRINTING AND CONTROL UNIT FOR USE IN NUCLEAR MEASUREMENTS. K. B. Hansen (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). Oct. 1963. 16p.

The principal logical scheme of a printing unit and a control unit designed for automatic collection of data from experimental nuclear measurement systems is presented. The maximum rate of printout is 2 lines per second, with a maximum line length of 24 digits. The units have some error-detection properties, controlling the behavior of the printing unit in some cases the sources of data, for instance if these are nuclear scalers. An example is given of the detailed circuits, which are based upon double-polarity logical circuits using complementary transistors. (auth)

14218 (TID-20244) THE USE OF A SEQUENTIAL ROUTING DELAY IN THE STUDY OF TIME DEPENDENT NEUTRON THERMALIZATION. Ralph Fullwood (Rensselaer Polytechnic Inst., Troy, N. Y.). [nd]. Contract AT(30-3)-328. 6p.

The problem of relative normalization of different time-dependent neutron thermalization spectra is overcome by the use of a device that sequentially increments the time at which the spectra is measured and routes the information to the proper location in the memory of a time analyzer. The delay and its operation are described, and typical thermalization spectra are shown. (auth)

14219 (TID-20246) SPARK CHAMBER STUDY: EFFECT OF VOLTAGE RISE TIME ON SECOND SPARK EFFICIENCY. D. N. Michael and R. A. Schluter [Argonne National Lab., Ill.]. Aug. 15, 1963. Contract [W-31-109-eng-38]. 23p.

The efficiency of spark formation in a neon spark chamber was measured as a function of voltage rise time on the plates of the chamber for times greater than approximately 10 nanoseconds. Attention was given to the competing breakdown in two electrically equivalent gaps. It was shown that the probability for spark formation in the two gaps is not independent. Three plate separations were used: 0.125, 0.250, and 0.375 inch. The neon was at atmospheric pressure, and its purity was controlled and checked. (auth)

14220 (UCRL-7043) A MÖSSBAUER SPECTROMETER. Rex Booth and C. E. Violet (California. Univ., Livermore. Lawrence Radiation Lab.). Feb. 28, 1963. Contract W-7405-eng-48. 32p.

The detector and velocity transducer components of a Mössbauer spectrometer are described. The energy resolution of the detecting system and the velocity resolution of the spectrometer are discussed in terms of the 14-kev

line of Fe^{57}. Special techniques used in conjunction with studies of the 35-kev transition of Te^{125} are described. The hyperfine splittings of the ground and first excited states of Fe^{57} are reported as an indication of the possible utility of the spectrometer in the study of narrow line resonances. (auth)

14221 (UCRL-10317) COUNTER DATA RECORDING FOR ANALYSIS BY COMPUTERS. Clyde Wiegand (California. Univ., Berkeley. Lawrence Radiation Lab.). June 12, 1962. Contract W-7405-eng-48. 12p. (CONF-432-1)

From Conference on Nuclear Physics, Claremont, Ferrand, France, June 1962.

The use of a computer system to record data from a large counter array is described and is illustrated by consideration of an experiment on beta decay of mesons(π^+). (D.C.W.)

14222 (UCRL-11146) DIRECT-VIEW VIDICON SCANNING SYSTEM FOR SPARK CHAMBERS. Sypko W. Andreae, Quentin A. Kerns, Frederick A. Kirsten, Dick A. Mack, Thomas A. Nunamaker, and Victor Perez-Mendez (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 28, 1964. Contract W-7405-eng-48. 9p. (CONF-182-4)

From 9th Scintillation and Semiconductor Counter Symposium, Washington, D. C., Feb. 1963.

A vidicon camera tube furnishes an ideal means for directly viewing spark-chamber events. By digitizing spark locations initially, one can perform the subsequent circuit logic by digital-circuit techniques. Information stored on magnetic tape can be presented in a format suitable for immediate analysis by a computer. A recent system for scanning two views of 12 spark-chamber gaps is described along with plans for future developments. (auth)

14223 (UCRL-11170) AN ATTEMPT TO MAKE A FLAT-RESPONSE NEUTRON DETECTOR. Takatoshi Hitaka (California. Univ., Berkeley. Lawrence Radiation Lab.). Dec. 27, 1963. Contract W-7405-eng-48. 21p.

A valuable instrument for health physicists would be a neutron detector with a uniform response to neutrons with energies ranging from thermal to fast. A simple variable-thickness moderator was produced and used with a BF_3–filled proportional counter. It was found that there is a good possibility of making a flat-response neutron detector in the range from thermal energies to about 10 Mev and that the average neutron energy can be determined by measuring the maximum detector sensitivity to a field of neutrons of unknown energies. (auth)

14224 (UCRL-11245) A NEW PARTICLE IDENTIFIER TECHNIQUE FOR Z = 1 AND Z = 2 PARTICLES IN THE ENERGY RANGE >10 Mev. Fred S. Goulding, Donald A. Landis, Joseph Cerny, III, and Richard H. Pehl (California. Univ., Berkeley. Lawrence Radiation Lab.). Feb. 3, 1964. Contract W-7405-eng-48. 24p. (CONF-182-2)

From 9th Scintillation and Semiconductor Counter Symposium, Washington, D. C., Feb., 1963.

The technique uses a ΔE (thickness T) and E counter, together with the empirical range-energy relation $R = aE^{1.73}$, where a depends on the type of particle. The quantity $T/a = (E + \Delta E)^{1.73} - E^{1.73}$ is obtained using this range-energy relation. T/a is calculated using logarithmic elements to produce a characteristic output for each type of particle. Mixtures of five types of particles with a fairly wide energy spread can be handled. Experimental results obtained with the system and Li-drifted Si detectors illustrate the clear separation between He^3 and He^4 particles. (auth)

14225 (UCRL-11302) A SURVEY OF THE APPLICATIONS AND LIMITATIONS OF VARIOUS TYPES OF DETECTORS IN RADIATION ENERGY MEASUREMENT. Fred S. Goulding (California. Univ., Berkeley. Lawrence Radiation Lab.). Feb. 18, 1964. Contract W-7405-eng-48. 31p. (CONF-182-3)

From 9th Scintillation and Semiconductor Counter Symposium, Washington, D. C., Feb. 1963.

A collection is presented of data relevant to the use of various types of semiconductor detectors in nuclear spectroscopy and examples are given of the use of detectors in specific experimental applications. Basic data on absorption of various kinds of radiation in germanium and silicon are given, and these are related to the characteristics of different types of semiconductor detectors. A brief outline of the optimization procedure for the detector-amplifier system to obtain good energy resolution follows. Included in a brief review of applications of detectors are examples in the fields of α-particle spectrometry, high-energy particle reactions, and low-temperature nuclear alignment studies. (auth)

14226 (AEC-tr-6345) CHAPTER 8. PHYSICAL PHENOMENA IN THE SCINTILLATION COUNTER. Werner Hartmann and Fritz Bernhard. Translated by Elmar K. Wilip (Argonne National Lab., Ill., from p.117-19 of "Fotovervielfacher und Ihre Anwendung in der Kernphysik," Akademie-Verlag, Berlin, 1957. 4p.

Studies were made on the physical phenomena in the scintillation counter up to the development of a charge impulse at the secondary-emission multiplier (SEV) anode, by using the example where a β particle impinges against the scintillator. (P.C.H.)

14227 MEASUREMENT OF γ-DOSE RATE DISTRIBUTION IN THE VERTICAL BEAMHOLES OF THE VVR-S REACTOR BY MEANS OF AN IONIZATION CHAMBER. L. Schaechter (Institutul de Fizica Atomica, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 489-97(1963). (In Rumanian)

In studies involving determination of the effect of γ radiation of a reactor on the physical properties of materials, the axial distribution of the dose rate in the beamholes must be known. In order to be able to carry out such measurements in the vertical beamholes of the VVR-S reactor, an ionization chamber suitable for determining high γ-dose rates, was constructed. The 10-cm^3 air-equivalent chamber had a saturation voltage of 70 v; graphite was used for the walls and central electrode and steatite for insulation. The measurements were carried out after the shutdown of the reactor and at various power levels during operation, determining the variations of the γ flux in 2 beamholes at the median cross section of the core. It was found that the dose rate varies with time after shutdown of the reactor according to an exponential expression. For short time periods, 50 and 100 minutes after shutdown, different slopes were obtained for the 2 beamholes placed at different distances from the center of the core. The dose rate also followed 2 different laws, depending on the height: from the center of the core to its edge, or 25 cm, it followed a cosine function, similar to the thermal flux distribution, while beyond 25 cm, its shape corresponded to an exponential function. (TTT)

14228 ABSOLUTE MEASUREMENT OF RADIONUCLIDES AT THE METROLOGY LABORATORY USING THE CAVITY IONIZATION METHOD. J. Cohen, M. Oncescu,

and Fl. Rebigan (Inst. of Atomic Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 619-26(1963). (In Rumanian)

An installation for the absolute measurement of gamma-emitting radioisotopes, based on the principle of the cavity ionization chamber, is described. The results obtained during the calibration of four sources of Co^{60}, with activities between 20 and 13 mc, are reported. The maximum error is 2%. (tr-auth)

14229 PHOTON ENERGY MEASUREMENT IN XENON BUBBLE CHAMBER IN THE ENERGY INTERVAL 20–1000 Mev. O. Czyżewski, J. Danysz, and Z. Strugalski (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Physiol. Polon., 24: 509-13(Oct. 1963).

A simple and quick method is presented for making photon-energy measurements in the xenon bubble chamber, in the energy interval 20 to 1000 Mev. (auth)

14230 A TIME-OF-FLIGHT SPECTROMETER FOR FAST NEUTRONS. A. Graue and A. Erdal (Univ. of Bergen, Oslo). Arbok Univ., Bergen, Mat.-Nat. Ser., No. 15, 10p. (1962).

A short description is given of a time-of-flight spectrometer for fast neutrons. The spectrometer is of the type first described by G. C. Neilson and D. B. James with some modifications. The time resolution obtained with the spectrometer is 1.0 n sec. The two neutron groups from the reaction $Be^9(d, n\gamma)B^{10}$ corresponding to the excited states at 2.15 and 1.74 Mev in B^{10} were completely resolved. (auth)

14231 AN IMPROVED EXPERIMENTAL METHOD FOR INTERNAL CONVERSION COEFFICIENT MEASUREMENTS. P. H. Blichert-Toft and P. Kugler (Chalmers Tekniska Högskola, Göteborg). Arkiv Fysik, 25: 317-33(1964).

A description is given of an instrument for electron-gamma coincidence measurements. Magnetic momentum selection is provided in the electron channel. No magnetic interference between the electron and gamma channels for electron energies below 2 Mev exists. The figures of merit of the beta-gamma coincidence spectrometer are considered to be superior to those of similar existing instruments as far as the determination of internal conversion coefficients is concerned. Several checking experiments were performed. These concern, for example, transmission calibrations for different instrument settings as well as an investigation of the linearity of the magnetic field strength versus current. The optimal operating conditions of the beta detector, from the point of view of detecting electrons with as low an energy as possible, were adjusted by trial and error techniques. (auth)

14232 A NEUTRON CRYSTAL SPECTROMETER USED AT FRG FOR MEASUREMENTS OF THERMAL NEUTRON SPECTRA AND TOTAL CROSS SECTIONS. Erich Bagge and Hasso Kuersten. Atomkernenergie, 9: 47-53(Jan.-Feb. 1964). (In German)

Design, operation, resolution function, and energy interval of a neutron crystal spectrometer at the FRG-1 are described. To carry out the analysis of neutron resonances an equation for the resonance parameters is given, which facilitates a correction of Doppler broadening. The thermal neutron flux spectrum through one of the beam holes, measured with this instrument, was analyzed and expressed analytically in the energy interval 10^{-3} ev < E < 3 ev. The Maxwell distribution gave an effective temperature T_{eff} = 327°K ± 2.5% with the moderator temperature at T_{Mod} = 308°K. The error in this measurement depends upon the accuracy with which the instrument transfer function is known. The result was compared with theory. (auth)

14233 NOVEL INSTALLATION FOR LOW-LEVEL COUNTING FOR THE MEASUREMENT OF Sr^{90} IN THE BONES OF HUMANS. Pierre Lerch and Paul Bercier (Hôpital Cantonal Universitaire, Lausanne, Switzerland). Chimia, 18: 16-20(Jan. 1964). (In French)

A low-level counting installation for measurement of very weak β activities is described. Eight G-M thin-window counters are surrounded by a single anticoincidence ring, and then by steel, borated paraffin, and lead shielding. The eight counters can work at the same time without any interaction. Each of them has an overall efficiency of 0.36 and a background of 0.28 cpm. (auth)

14234 DETERMINATION OF THE OPTIMUM CONDITIONS FOR FILLING OF ORGANIC-QUENCHED GEIGER-MÜLLER TUBES. S. M. Karim and M. Hafeez Qureshi (Univ. of Karachi, West Pakistan). J. Nat. Sci. and Math., 3: 107-18(Oct. 1963).

Conditions are determined for filling G-M tubes with proper ratios of Ar and ethanol and for setting the pressure of this mixture in the tube. The plateau range, slope, and the threshold voltage are determined for each variable. The photoelectric effect is determined. The results show that a mixture of 90% Ar and 10% ethanol at a pressure of 9 to 10 cm Hg gives optimum results. (auth)

14235 MEASUREMENT OF LOW ENERGY BETA RAYS WITH THE LIQUID SCINTILLATION DETECTED BY THE PHOTOMULTIPLIER COOLED WITH THERMO-ELEMENTS. Yasushi Nishiwaki (Tokyo Inst. of Tech.), Hiroshi Kawai, Yotaro Oshima, and Masaki Koyama. J. Radiation Res. (Japan), 4: 16-25(Mar. 1963).

In ordinary liquid scintillation counting the vial containing the sample and the photomultiplier are kept at low temperature in a large refrigerator. However, in order to avoid the possible undesirable effects of cooling the sample, only the photomultiplier was cooled to a temperature of −15 to 20°C with thermo-elements to reduce the noise. Even if it were cooled to a lower temperature, the reduction of noise would be slight. Therefore a simplification of liquid scintillation counting can be achieved without cooling the sample by replacing the large refrigerator with small thermo-elements cooling only the photomultiplier. (auth)

14236 A NEUTRON-INSENSITIVE CHEMICAL DOSIMETER FOR γ RADIATION. Zdeněk Spurný, Jarmila Šulcová, and Jiří Hruška (Inst. of Nuclear Research, Czechoslovak Academy of Sciences). Jaderná Energie, 9: 329-31(Oct. 1963). (In Czech)

Measurement of neutrons and γ radiation within a broad energy range presents a complex problem; the effect of heat and the energy level of the radiation on the detecting system must be taken into account. In order to overcome these difficulties, a chemical dosimeter based on the data published by S. C. Sigoloff (Selected Topics in Radiation Dosimetry, 337, (1961)) and using tetrachloroethylene was further developed. For a better understanding of the principles involved, the radiolysis of CCl_4 was investigated, because it was planned to use this material in the improved dosimeter. The dose determination was based on spectrometric measurement of free Cl_2. The radiolysis was found to yield phosgene and free Cl_2. The characteristic peak of Cl_2 at 325 mμ made it possible to determine concentrations as low as 10^{-5}M. Tests carried out with a cascade generator and with the √VR-S reactor also showed that the CCl_4 is only slightly affected by the neutron radiation. (TTT)

14237 A PARAFFIN-MODERATED 4π-NEUTRON DETECTOR. Eizo Teranishi, Bunji Furubayashi, Taichi Michikawa, Misao Kageyama, and Osamu Yura (Electrotechnical Lab., Tokyo). Japan J. Appl. Phys., 3: 36-44 (Jan. 1964).

A flat-response 4π-neutron detector was constructed by arranging BF_3 counters in multiple concentric rings in a cylindrical paraffin moderator. The sensitivity is flat within ±5% for neutrons between 50 and 700 kev. The absolute efficiency is 2.24% for 50- to 700-kev neutrons and 1.76% for Pb^{210}–Be neutrons in the standard counter arrangement. This efficiency can be increased by mounting more BF_3 counters but the relation is not linear because of the mutual interference effect in BF_3 counters. The dependence of the counting efficiency on the angular distribution of neutron source was investigated by measurements of thermal neutron distributions in the moderator, and it has proved to be quite small (<1.5%) even for the $T^3(p,n)He^3$ reaction in its threshold region. (auth)

14238 RELATION BETWEEN PLATEAU AND PULSE SIZE CHARACTERISTICS IN ORGANIC GAS-QUENCHED G. M. COUNTER TUBES. Juichi Akutsu and Kiyoshi Kanno (Inst. of Physics and Chemical Research, Tokyo). Japan J. Appl. Phys., 3: 56-7(Jan. 1964).

Plateau-pulse size characteristics were studied for G-M tubes filled with argon–ethyl alcohol (10-to-1), argon–ethyl formate (35-to-1), and helium–isobutane (99-to-1). (R.E.U.)

14239 COMPETITIVE STUDIES OF DIFFERENT SEALED RADIOACTIVE SOURCES USED FOR AN ARGON IONIZATION DETECTOR IN GAS CHROMATOGRAPHY. U. Proesch, G. Vormum, and H. J. Zoepel (Inst. for Applied Isotope Research and Inst. for Medicine and Biology, German Academy of Sciences, Berlin-Buch). Kernenergie, 7: 26-33(Jan. 1964). (In German)

For the Bothe argon ionization detector, 10- and 1-mC Sr^{90} preparations, 500-mC H^3 sources, and 5-mC Kr^{85} preparations were examined with regard to their relative detection sensitivity and their performance under gas-chromatographic conditions. The radiation protection determination was also considered. It was found that the use of 5 mC Kr^{85} in a suitably prepared form is suitable for the gas-chromatographic detector under consideration. (tr-auth)

14240 A TRANSISTORIZED SCINTILLATION COUNTER WITH PULSE-HEIGHT ANALYSER. H. Mahnau and W. Marinz (HERFURTH GmbH, Hamburg). Kerntechnik, 6: 9-12(Jan. 1964). (In German)

A fully transistorized scintillation counter for the requirements of radiation protection is described. The counter uses a pulse-height analyzer, a linear amplifier, transformer-coupled emitter-followers, and a logarithmic ratemeter. (P.C.H.)

14241 DETERMINATION OF EXTREMELY LOW ACTIVITIES. W. Klein and L. Kuhn (Firma Frieseke and Hoepfner GmbH, Erlangen, Ger.). Kerntechnik, 6: 13-17(Jan. 1964). (In German)

A quality factor for low-level installations is defined from the requirement of a minimum counting time. The quantities appearing in this factor are discussed and indications for an optimum layout of measuring arrangements are given. A description of special installations follows. (auth)

14242 TRANSISTORIZED NEUTRON-FLUX AMPLIFIER. K. Suedland (Hartmann and Braun AG, Frankfurt am Main). Kerntechnik, 6: 17-19(Jan. 1964). (In German)

The electrical circuit and the theory of an all-semiconductor neutron-flux amplifier are discussed. The feedback for the measurement of current is described, and it is shown that the amplifier without feedback has an input impedance of 50,000 MΩ as necessary for the measurement of 10^{-11} Å. This was achieved with 2 Varicap diodes where the junction capacity is controlled by the d-c input current. The input current is being transformed into a proportional a-c, which is rectified after the a-c amplification. The design of the self-oscillating amplifier eliminates the otherwise necessary phase discriminating rectification as used in ordinary d-c chopper amplifiers. (auth)

14243 CONNECTORS FOR GEIGER-MUELLER-COUNTERS ACCORDING TO DIN. R. Krauss and H. Bannmann. Kerntechnik, 6: 26(Jan. 1964). (In German)

Standardization of connectors for Geiger-Mueller tubes and other similar uses according to the published outline of the German industry standard DIN 44 424 for their seal is discussed. Diagrams are shown. (M.C.G.)

14244 THE STATISTICAL ERRORS IN THE MEASUREMENT OF RADIOACTIVE PREPARATIONS. Sigfrid Mueller. Mitteilungsbl. Strahlungsmessgeraete, No. 1, 5-8(Feb. 1960). (In German)

Measurements of radioactive materials using statistical errors in measurement are discussed. Topics covered include: concept of statistical errors, determination of statistical errors, and use of statistical errors in the measurement of radioactive preparations by pulse counting. Four examples are given. (M.C.G.)

14245 THE BF_3 COUNTER FOR DETECTION OF THERMAL NEUTRONS. G. Waechter. Mitteilungsbl. Strahlungsmessgeraete, No. 1, 8-11(Feb. 1960). (In German)

Use of BF_3 proportional counters for detecting thermal neutrons is discussed. The design and operation of the counter are described. Sensitivity is shown. (M.C.G.)

14246 DETECTION OF THERMAL NEUTRONS WITH A SCINTILLATION COUNTER. H. Weiss. Mitteilungsbl. Strahlungsmessgeraete, No. 2, 9-12(Apr. 1960). (In German)

Use of scintillation counters for detection of thermal neutrons is discussed. The neutrons are allowed to react with a selected isotope to produce an alpha particle or gamma radiation, which is detected by the scintillator. Performances of selected detectors are discussed. (M.C.G.)

14247 ON THE RADIO PAPER CHROMATOGRAPHY OF SOFT BETA RADIATION. R. Neuwirth and L. Weise. Mitteilungsbl. Strahlungsmessgeraete, No. 3, 6-8(Sept. 1960). (In German)

In radio-paper chromatography with beta-emitting radioisotopes, extremely soft beta emitters cannot be measured by end-window counters because of the radiation absorption by the windows. A methane flow counter with a special diaphragm was developed for measuring beta radiation. For an evaluation of the method, chromatographic strips were impregnated with $Na_2C^{14}O_3$ and measurements were made. Results are shown in figures. Measurement errors are discussed. (M.C.G.)

14248 ARRANGEMENT FOR MEASUREMENT OF LOWEST α AND β ACTIVITIES. FHK 81/60A. W. Klein. Mitteilungsbl. Strahlungsmessgeraete, No. 3, 8-11(Sept. 1960). (In German)

Measurements of small amounts of α and β activity at low energies are discussed. An instrument for such measurements is described. (M.C.G.)

14249 ON THE WORK WITH 4-π COUNTERS. L. Kranz and R. Neuwirth. Mitteilungsbl. Strahlungsmessgeraete, No. 6, 10(Oct. 1961). (In German)

The performance of 4-π counters is discussed. Sources of error and response characteristics are described. (M.C.G.)

14250 GAMMA SPECTROMETRY WITH SCINTILLATION COUNTER AND SINGLE-CHANNEL PULSE-HEIGHT ANALYZER. K. H. Waechter. Mitteilungsbl. Strahlungsmessgeraete, No. 8, 3-17(Aug. 1962). (In German)

Luminescence excitation in NaI(Tl) crystals by gamma radiation is discussed. Photoeffect, Compton effect, pair formation, total absorption, and excitation by primarily formed electrons are described. The transformation of luminescence into electric pulses and their evaluation using photomultipliers and pulse-height-distribution registers are discussed. The formation of a simple line spectra as in $Cs^{137} \rightarrow Ba^{137*}$, a many-line spectra as for Co^{60}, a spectrum with pair-formation effects as in Na^{24}, the spectrum of a positron emitter such as Na^{22}, a spectrum with escape lines as for Tm^{170}, and the spectrum of a K-emitter such as Fe^{55} is described. The resolution possibility of a scintillation spectrometer is discussed. The influence of such operating conditions as voltage fluctuations, temperature changes, and pulse rate variations on the intensification of a scintillation counter is considered. The effects of the geometry of the test arrangement, the statistics of radioactive decay, and the distortion of the register curve on the form of the spectrum are discussed. Suppression of disturbing radiation by measurement in the channel is described. (M.C.G.)

14251 USE OF THREE-CHANNEL COINCIDENCE-ANTICOINCIDENCE INTENSIFIERS. W. Klein and L. Kuhn. Mitteilungsbl. Strahlungsmessgeraete, No. 9, 3-8(Feb. 1963). (In German)

A three-channel coincidence-anticoincidence intensifier register is described and schematic diagrams are given. Uses as a Compton, anti-Compton, pair, and fluid spectrometer are discussed. A method for alpha-beta separation with a proportional counter is described. An installation for identification of unknown beta emitters is also considered. (M.C.G.)

14252 CONTINUOUS WATER MONITOR. S. Mueller. Mitteilungsbl. Strahlungsmessgeraete, No. 9, 12-17(Feb. 1963). (In German)

Equipment for continuous measurements of the amount of radioactive materials in water is described. Measuring methods, limits, and sensitivity are discussed. Methods for monitoring alpha, beta, and gamma activities are considered. The different monitors are compared. (M.C.G.)

14253 NUCLEAR TRANSDUCERS. D. P. Roux. Nucl. Safety, 5: No. 2, 168-9(Winter 1963-64).

A brief survey is presented of nuclear transducers. Fission counters are discussed in some detail. The development of semiconductor devices for core flux mapping is described. (D.L.C.)

14254 NEW CRITICALITY MONITORING SYSTEMS IN THE GASEOUS DIFFUSION PLANTS. D. M. Papke. Nucl. Safety, 5: No. 2, 169-72(Winter 1963-64).

A dose-sensitive radiation excursion detector with rate compensation was developed in 1960, and radiation alarms of this type were installed in the three AEC gaseous diffusion plants. A description is given of the alarm installed at Oak Ridge, and operating experience and false evacuation alarms for all three plants are described. (D.L.C.)

14255 PERSONNEL MONITORING. E. D. Gupton. Nucl. Safety, 5: No. 2, 192-6(Winter 1963-64).

A review is presented of recent developments in the art of personnel monitoring. These developments include neutron monitoring, alpha aerosol monitoring, thermoluminescent dosimetry, low-background monitoring, and personnel meters. (D.L.C.)

14256 SELF-POWERED DOSIMETER FOR GAMMA AND X-RADIATION. Rolf Hosemann and Harold F. H. Warrikhoff (Fritz Haber Inst. of the Max Planck Society, Berlin). Nucleonics, 22: No. 3, 51-2; 54(Mar. 1964).

The design and performance of a dosimeter, which contains a "roentgen element" in which the voltage difference caused by emission of photo- and Compton electrons from two electrodes gives a measure of the gamma and x-ray dose, are discussed. The dosimeter consists of a photocell in a vacuum tube and a quartz-fiber electrometer from which 2 to 500 r can be read. The photocell electrodes are of lead and carbon. (R.E.U.)

14257 METAL CONTAINERS FOR AQUEOUS BENZENE-PHENOL DOSIMETERS. F. W. Bloch, F. J. Haasbroek, and D. R. MacKenzie (Brookhaven National Lab., Upton, N. Y.). Nucleonics, 22: No. 3, 77(Mar. 1964).

The compatibility of aqueous benzene with aluminum, copper, nickel, and stainless steel is reported. Phenol concentrations are found from absorbance values from spectrophotometric examination of the irradiated benzene. (R.E.U.)

14258 A COINCIDENCE MEASUREMENT APPARATUS FOR ELECTRON ENERGIES UNDER 50 Kev. Hans-Joachim Beier and Klaus Tradowsky (Technische Universität, Berlin). Nukleonik, 5: 330-7(Dec. 1963). (In German)

A coincidence device for electrons in the energy range between 50 and 20 kev is described. The coincidence device is also suitable for the measurement of γ coincidences. For γ coincidence measurements, the minimum resolution time is $2\tau = 1.3$ nsec, and the coincidence yield is then 15%. In the measurement of coincidence electrons, the resolution time depends on the necessary coincidence yield. With coincidence electrons with an energy of 50 kev, a minimum resolution time $2\tau = 2.2$ nsec can be obtained with a coincidence yield $\epsilon_{50\ kev} = 2.5\%$. With a resolution time $2\tau = 5$ nsec, the yield lies between $\epsilon_{20\ kev} = 58\%$ and $\epsilon_{50\ kev} = 95\%$. The resolution times and yields obtainable were determined essentially with the scintillation detector. The scintillation detector consists of a NE 102 synthetic scintillator with a 14-stage RCA 6810 A photomultiplier. A diode circuit was used in the coincidence mixing stage. (tr-auth)

14259 THE COINCIDENCE MEASUREMENT OF β-γ PREPARATIONS USING A γ SCINTILLATOR AND A γ SINGLE-CHANNEL DISCRIMINATOR. (APPLICATION TO THE ABSOLUTE MEASUREMENT OF THE DECAY RATE OF Mn^{56}). Karlheinz Klemt (Technische Hochschule, Munich). Nukleonik, 5: 322-30(Dec. 1963). (In German)

An expansion of the very successful coincidence method developed for the accurate absolute measurement of the decay rate of radioactive preparations is described. By utilization of a scintillation counter with a single-channel discriminator for the detection of the γ radiation at the site of the counter tube, the decay rate of the isotope Mn^{56}, previously unaccessible to coincidence measurements, could be determined under favorable conditions to 1%. (tr-auth)

14260 WHOLE-BODY COUNTER FOR INTERNAL CONTAMINATION CONTROL. Stanislaw Pszona, Bozena Adamska, and Krzysztof Zarnowiecki (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 565-72(1963).

A facility for body radioactivity measurements was built and put in service in the Institute of Nuclear Research. Two scintillation counters NaI(Tl) working in a coupled detection system were used as detectors. A calibration in vivo for isotope K^{42} was performed. A calibration with phantom was made for Au^{198}, Mn^{56}, K^{42}, and Na^{24}. By comparison of the energy spectra obtained for patient and for phantom it was established that phantom gives a good approximation of absorption and scattering of the radiation in the body. The dependence of the sensitivity on radiation energy was established. The K^{40} and Cs^{137} contents in the human body were determined. (auth)

14261 A LOW-BACKGROUND BETA SCINTILLATION COUNTING METHOD. Zbigniew Jaworowski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 681-5(1963).

For measurements of minute beta activities a scintillating counter was used, whose mean background counts were 0.44 cpm. The low background pulses were obtained without applying the anticoincidence system, by using a detector constructed from scintillating plastic foil 0.3 mm thick. (auth)

14262 256-CHANNEL TIME-OF-FLIGHT ANALYZER WITH MAGNETIC MEMORY. Zbigniew Hoffman, Zenon Komor, and Aleksander Sawicki (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 695-707(1963). (In Polish)

The principle of work and description of a 256-channel time-of-flight analyzer is given. The instrument is constructed on the basis of the digital computer technique and is composed of some blocks such as: magnetic memory, address register, arithmetic unit, and data printing unit. The instrument was designed for time of flight measurement of neutrons. (auth)

14263 THE INFLUENCE OF THE ANALYZER CHANNEL WIDTH OF THE SHAPE OF THE PHOTOPEAK OF A MONOENERGETIC GAMMA LINE. Slawomir Sterlinski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 709-12(1963).

The influence of the analyzer channel width on the shape of the photopeak of a monoenergetic gamma line is determined mathematically. It is shown that the shape of the photopeak can be represented by a Gaussian curve. (P.C.H.)

14264 DISTORTION OF THE ELECTRIC FIELD IN AN IONIZATION CHAMBER DUE TO A DIFFERENCE IN POTENTIAL BETWEEN GUARD RING AND COLLECTOR. J. W. Boag (Mount Vernon Hospital, Northwood, Middx, Eng.). Phys. Med. Biol., 9: 25-32(Jan. 1964).

The change in the electric field pattern in an ionization chamber arising from small differences in potential between guard ring and collecting electrode is investigated. It is shown that the resulting field distortion may cause appreciable changes in the active volume of the chamber. (auth)

14265 A WHOLE-BODY COUNTER FOR CLINICAL APPLICATIONS. H. I. Glass, D. G. Clarkson, and H. G. Burns (Western Regional Hospital Board, Glasgow). Phys. Med. Biol., 9: 57-63(Jan. 1964).

The characteristics of a whole-body counter using a 7 in. diameter plastic scintillator and a meter in an unshielded room are described. This device offers useful clinical facilities with the advantages of low cost, reasonable sensitivity and simplicity of operation. (auth)

14266 A FOCUSING COLLIMATOR WITH FINE RESOLUTION. R. Sear and R. Wilks (London Hospital). Phys. Med. Biol., 9: 83-8(Jan. 1964).

A focusing collimater is described which incorporates a number of novel design features. Compared with the conventional multi-channel device it is much simpler in mechanical construction, affords finer resolution and a much improved source to background count-rate ratio. It is considered that the device could prove very valuable in situations where the sensitivity of response was not the limiting factor. (auth)

14267 AN IMPROVED TYPE OF CRYSTAL ASSEMBLY FOR AUTOMATIC SAMPLE CHANGERS. J. R. Kemplay (London Univ.). Phys. Med. Biol., 9: 89-92(Jan. 1964).

An improved type of NaI (Tl) crystal assembly for automatic sample changers is described. The efficiency of the crystal is compared with that of a well type crystal for I^{131}, and mechanically simpler methods of sample handling resulting from the use of the improved crystal assembly are suggested. (auth)

14268 DOSIMETRY OF IONIZING RADIATIONS BY GLASS DETERMINATION DEVICES. P. Pizon. Presse Med., 70: 1650-1(July 14-21, 1962). (In French)

Radiophotoluminescence may be induced in glasses by ionizing radiation. A phosphate glass activated by Ag is known to be especially efficient; an apparatus containing such a detector is described. The glass is formed into small cylinders called fluorods. The sensitivity of the apparatus is ±50 r for a dose of 150 r and ±5% for 500 r. Several fluorods must be used simultaneously to reduce error. The usual formula for the absorbed energy from a 1 r dose is given. The region of usefulness of this method is that characteristic of the high energies of the usual radioactive isotopes in medicine; the small dimensions of the fluorods allow their use in vivo in experimental study. As an example, the dose from a radium needle in water is presented as a function of distance. The use of a complex device containing several needles, tubes, discs or spheres is suggested. With monoenergetic photons, the glass determination device may be used without special precautions; this is not the usual case. If the glass is buried in an organic mass, heterogeneous radiation results from a combination of direct and degraded (by diffusion) radiation, and a filter must be used. This may be either Au or Pt of thickness 0.02 to 0.60 mm. If the sensitivity of the glass extends to about 2 Mev, this filtration permits spectral studies to about 253 kev. In medical applications, the precision is of the order of ±5%. (BBB)

14269 THE RESPONSE OF ^{6}LiI(Eu) TO NEUTRONS AS A FUNCTION OF TEMPERATURE. J. R. P. Eaton and J. Walker (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 83: 301-9(Feb. 1964).

The response of a $Li^{6}I$(Eu) scintillation spectrometer as a function of temperature was investigated down to 77°K. As previously observed the resolution to fast neutrons improves at lower temperatures. The pulse height from neutrons increases with fall in crystal temperature and reaches a maximum at about 120°K. Murray and Meyer's model of the luminescent process in ionic crystals was extended to explain this behavior in terms of electron traps. This explanation is further supported by an observed increase in efficiency of the phosphor to α particles relative to tritons, and neutrons relative to gamma radiation, and also by the

response of the crystal as a function of neutron energy at room temperature and liquid nitrogen point. (auth)

14270 SPARK CHAMBERS. J. G. Rutherglen. Progr. Nucl. Phys., 9: 1-26(1964).

Principles of operation of triggered spark chambers, gaseous processes involved in spark chamber operation, construction of spark chambers, and the electronics of spark chambers are discussed. Applications are discussed. (R.E.U.)

14271 SEMICONDUCTOR COUNTERS. G. Dearnaley. Progr. Nucl. Phys., 9: 27-69(1964).

The theory and nomenclature of insulators and semiconductors, the characteristics and advantages of conduction counters, the characteristics and preparation of semiconductor junctions, the design of pulse amplifiers for semiconductor detectors, and applications of semiconductor counters in low-energy nuclear physics are discussed. 73 references. (R.E.U.)

14272 THERMOELECTRIC NEUTRON DETECTOR. Leszek Łabno, Wacław Dabek, and Adam Kazimierski (Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw). Przeglad Elektron., 4: 713-16(1963). (In Polish)

Development of a thermoelectric neutron detector with thermoelements of Cr–Cu or Cr–Al and a signal of 0.1 to 100 mV is described. Construction technology and results of tests are discussed. (M.C.G.)

14273 LIQUID-FLOW HALOGEN G-M COUNTER WITH HELIX ANODE AND THINWALL TUBE IN ACTIVE VOLUME. Jan Lesiński and Maciej Jankowski. Przeglad Elektron., 4: 716-18(1963). (In Polish)

14274 PROPORTIONAL GAS FLOW 4π COUNTER FOR CALIBRATING RADIOISOTOPES. Ya Asavinei, E. Burlaku, L. Grigoresku, K. Lazarovich, and M. Onchesku (Inst. of Atomic Physics, Bucharest). Rev. Phys., Acad. Rep. Populaire Roumaine, 8: 489-98(1963). (In Russian)

The design and performance of a 4-π counter are given. The techniques for eliminating self-absorption errors in β counting and source standardization are discussed. (R.V.J.)

14275 SYNCHROCYCLOTRON 200-METER FLIGHT PATH NEUTRON VELOCITY SPECTROMETER. J. Rainwater, W. W. Havens, Jr., and J. B. Garg (Columbia Univ., New York). Rev. Sci. Instr., 35: 263-75(Mar. 1964).

The synchrocyclotron neutron time-of-flight spectrometer uses a 200-m flight path and two 2000-channel analyzers. The modifications and improvements described have been made as a result of operating experience. The operation uses ~20 nsec bursts at an instantaneous intensity ~5×10^{18} evaporation neutrons per second and a 60-cps repetition rate. The resolution for energies above 1 kev is limited by the time analyzers, which have 100-nsec detection channel widths, giving a resolution of 0.5 nsec/m in the kev region. (auth)

14276 HIGH RESOLUTION DIFFERENTIAL ČERENKOV COUNTER. R. M. O'Donnell, D. H. Frisch, and S. R. Smith (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instr., 35: 360-5(Mar. 1964).

A simple high-resolution differential Čerenkov counter has been constructed and tested in beams of positive particles of 3.75 and 6 Bev/c momentum. The π meson, K meson, and proton peaks were well separated, and had full widths at half-height of about 10^{-3} in $\Delta\beta$. The total efficiency of the counter was 63%. The K peak to K-π valley ratio was 200 to 1 at 3.75 Bev/c and 375 to 1 at 6.0 Bev/c. The limitations of the counter for use at higher momenta are discussed briefly. (auth)

14277 LIQUID SCINTILLATOR ANTICOINCIDENCE GUARD. M. K. Moe, T. L. Jenkins, and F. Reines (Case Inst. of Tech., Cleveland). Rev. Sci. Instr., 35: 370-3 (Mar. 1964).

A study was undertaken to determine the reduction in cosmic ray background which can be obtained by anticoincidence techniques. A 50-liter liquid scintillation detector was set to register all cosmic ray events depositing more than 10 Mev. With a minimum shielding over the detector's basement location of 60 g/cm^2, all but one in 10^3 events were accompanied by a pulse greater than 100 kev in a 1500-liter liquid scintillator anticoincidence guard. An additional 600 g/cm^2, in the form of 35 tons of concrete block and bags of iron ore over the detector and anticoincidence guard, reduced the unaccompanied events to 1 in 10^4, or 7.7 counts/h through 0.35-m^2 effective horizontal area. (auth)

14278 CORRELATION OF I–V CHARACTERISTIC WITH NOISE FOR ION DRIFTED p-i-n JUNCTION PARTICLE DETECTORS. Larry K. Monteith (Bell Telephone Labs., Murray Hill, N. J.). Rev. Sci. Instr., 35: 388-92 (Mar. 1964).

A technique is described for achieving minimum noise in a p-i-n particle detector. The reverse saturation current of the detector and its relative noise are correlated for different surface treatments. The data show that the reverse current at the detector operating voltage is not a sufficient measure of relative noise. The relative noise can be predicted from the reverse current at two to three times the operating voltage. (auth)

14279 STUDY OF HIGH SPEED PHOTOMULTIPLIER SYSTEMS. L. G. Hyman (Argonne National Labs., Ill.), R. M. Schwarcz, and R. A. Schluter. Rev. Sci. Instr., 35: 393-406(Mar. 1964).

Steps taken to optimize the pulse shape and dynamic range from a 56 AVP photomultiplier are described. A model is discussed for the response of a photomultiplier. The parameters used in this model are obtained from direct measurements on a 56 AVP photomultiplier. Monte Carlo methods, as well as analytic techniques, are used to predict quantities such as distribution of triggering times, pulse shapes, etc. It is found, for example, that in the resolution of small time differences the predictions using the Monte Carlo method and the analytic treatment are in good agreement. The time resolution as predicted by the model is compared to experiment. (auth)

14280 THE LIQUID HYDROGEN REFRIGERATING PLANT OF THE CERN 2-METRE BUBBLE CHAMBER. C. Trepp. Sulzer Tech. Rev. (Switz.), 45: 111-20(1963).

A hydrogen refrigeration plant that eliminates preliminary nitrogen cooling is described. An output of 7.4 kw was achieved during 120 hours of continuous operation at 23°K. The layout, control, and auxiliary equipment as applied to a large bubble chamber are described. (R.E.U.)

14281 RADIATION-EXCITED CONDUCTIVITY PULSES IN CADMIUM SULFIDE CRYSTAL COUNTERS. Carl Rudolf Vidal and Ingolf Ruge (Technische Hochschule, Munich). Z. Angew. Phys., 16: 424-9(Jan. 1964). (In German)

Investigations of the radiation-excited conductivity pulses in CdS single crystals showed three different types of pulses: S pulse, V pulse, and R pulse. The S pulses originate from radiation-excited secondary electrons in the

crystal. The V pulses are formed by radiation-excited disturbance centers. The V pulses influence the sensitivity and inertness of the crystal. The R pulses appear only in the presence of impressed space charges in the interior of the crystal. (M.C.G.)

14282 KONTROL'NO-IZMERITEL'NAYA RADIOMETRICHESKAYA APPARATURA. (Recording and Measuring Radiometric Apparatuses). S. I. Babichenko, A. A. Bogdanov, L. S. Gorn, M. L. Kagan, L. N. Krylov, L. G. Ol'dekots, and B. I. Khazanov. Moscow, Gosatomizdat, 1963. 152p.

Construction of various transistorized systems and their application for measuring and recording radioactive emissions are discussed. Characteristics and parameters of various installations are presented, and block diagrams are given. (R.V.J.)

14283 PUZYR'KOBYE KAMERY. (Bubble Chambers). N. B. Delone, ed. Moscow, Gosatomizdat, 1963. 340p.

A systematic review is given of the construction, performance, and applications of bubble chambers. Special attention is given to the formation and observation of tracks. Bubble initiation, growth, and photography are discussed. (R.V.J.)

14284 MAGNETIC SPECTROGRAPHS AND BEAM ANALYZERS. Harald A. Enge (Massachusetts Inst. of Tech., Cambridge). 39p. (CONF-354-5)

From Accelerator Conference, Boston, Nov. 1963.

A brief discussion is given of some of the magnetic spectrographs and spectrometers in use today for studies of changed-particle nuclear reactions. The need for new instruments with improved resolving power, higher accuracy, larger solid angle, and better signal-to-background ratio is acknowledged. Possible improvements in the design of time-tested spectrographs and beam analyzers, as well as entirely new approaches, are discussed. (auth)

14285 REACTOR SPECTRUM MEASUREMENTS WITH A NEUTRON DECAY SPECTROMETER. R. A. Karam and T. F. Parkinson (Univ. of Florida, Gainesville). 4p. (CONF-187-92)

From American Nuclear Society Meeting, New York, Nov. 1963.

A neutron spectrometer is described that operates by detecting the protons from the neutron beta decay. The kinematics of the decay requires that the average energy of the emitted proton be about equal to the initial energy of the neutron, so that a determination of the proton spectrum is sufficient to determine the neutron spectrum. The instrument is suitable for use in the kev energy range. (T.F.H.)

14286 RADIATION RATEMETER. (to The Bendix Corp.). British Patent 950,559. Feb. 26, 1964. Priority date Mar. 30, 1960, United States.

An instrument is described for measuring radiation rates or intensities that consists of two relatively deflectable electrometer elements in an ionization chamber with a common source of potential. A high-resistance fiber is included that serves to introduce an imbalance between charges of opposite sign and ensures operation as a ratemeter rather than a dosimeter. (R.E.U.)

14287 RADIATION RATEMETER. (to The Bendix Corp.). British Patent 950,560. Feb. 26, 1964. Priority date Mar. 30, 1960, United States.

An instrument is described for measuring rates or intensity of ionizing radiation by observing the relative deflection between two electrometer elements placed under potentials of common polarity from a solid-ion battery or an alpha source incorporated in the instrument. (R.E.U.)

14288 NEUTRON FLUX MONITOR. David Campsie Menzies and Robert Brown (to United Kingdom Atomic Energy Authority). British Patent 950,896. Feb. 26, 1964. Filed Nov. 17, 1961.

A neutron flux monitor is described comprising elements of aluminum and boral alloy in a uniform thermal environment. A thermocouple is provided to detect any thermal differential in the elements. One element acts as a reference. (R.E.U.)

14289 IMPROVEMENTS RELATING TO RADIATION DETECTORS. David Vernon Freck (to Associated Electrical Industries Ltd.). British Patent 951,072. Mar. 4, 1964. Filed June 8, 1961.

A solid-state radiation detection instrument is described that comprises a p-n semiconductor, a Peltier cooling device in thermal contact with the semiconductor element, and a heat absorber in thermal contact with the Peltier cooling device. Improvement in energy resolution is accomplished. (R.E.U.)

14290 NEUTRONIC FLUX DETECTOR. Raymond Hauser and Henri Zyngier (to Electricite de France (Service National)). British Patent 951,316. Mar. 4, 1964. Priority date Oct. 23, 1961, France.

An apparatus for the continuous detection and measurement of neutron fluxes inside continuously operating reactors is described. A pellet of UO_2, Ag, or Mn, according to the power density, is provided in one of two cavities in the detector element. The pellet releases heat proportionally to the flux intensity while the second cavity acts as a control reference. Thermocouples are used to detect the temperature difference of the cavities and to provide a detectable current. (R.E.U.)

14291 PLUTONIUM DETECTOR. Howard C. Eberline (to Eberline Instrument Corp.). U. S. Patent 3,124,684. Mar. 10, 1964. Filed July 6, 1959.

A vehicle-mounted scintillation detector for selective-energy gamma rays, thereby permitting identification of material, is described. (R.E.U.)

ISOTOPE TECHNOLOGY

General

14292 (EURAEC-861) A STUDY OF THE SHAPING AND IRRADIATION OF URANIUM MONOCARBIDE. Quarterly Report No. 11, July 1–September 30, 1963. J. P. Dumas and B. Mansard (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). Oct. 10, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 080-62-3-RDF. 29p. (A translation).

The stripping of the first irradiation capsule in Melusine has not yet progressed sufficiently to report the results which brought the fuel, made of natural uranium carbide, to a burnup of 437 Mwj/t. The incidents which occurred during the out-of-pile tests of the EL-3 device enabled the completion of the equipment for testing. The development of methods and equipment for measuring thermal and electrical conductivity before and after irradiation is discussed. The fabrication and properties of zirconium carbide for use in high-temperature irradiation rigs are investigated. Measurements of the effective diffusion coefficient of fission gases on slightly irradiated monocrystals of uranium carbide gave hardly workable results, owing to their dispersion produced by superficial alteration in the crystals during manipulations before insertion in the pile. (N.W.R.)

14293 USES OF STABLE ISOTOPES. Tsi-chain Chen. Hua Hseuh Tung Pao, No. 9, 38-43(1963). (In Chinese)

The various uses of stable isotopes in research and medicine are reviewed. They are employed as isotopic tracers in organic chemistry for studying reaction mechanisms, spatial rearrangement, and isomerisation. In nuclear chemistry, exchange reactions, thermodynamics and kinetics are studied by means of these isotopes, which were found useful also for carrying out investigations in biochemistry and physiology on photosynthesis, metabolism, transport phenomena in the plants and for determining the amino-acids resulting from the hydrolysis of proteins. These materials were also used in research on future energy sources. The medical applications include the use of B^{10} for the treatment of cancer. In radiochemical studies stable isotopes were employed for the study of industrial high polymers and for the initiation of gas-phase reactions. (TTT)

14294 LOW-ENERGY BETA EMITTERS. PREPARATION, USE, AND MEASUREMENT METHODS. A. Manni. Mitteilungsbl. Strahlungsmessgeraete, No. 3, 3-6(Sept. 1960). (In German)

Preparation and applications of the most important beta emitters, tritium, C^{14}, and S^{35}, are described. Radiation protection in the use and handling of beta emitters is also described. Beta measurements using Geiger-Mueller tubes, autoradiography, beta-sensitive crystals, liquid scintillators, methane flow counters, ionization chambers, and gas-filled counters are described. (M.C.G.)

14295 EXACT RELATIVE MEASUREMENT OF THE Sr^{87}/Sr^{86} ISOTOPE RATIO WITH THE HELP OF A DOUBLE MULTIPLIER SYSTEM. Walter Seibt, Rainer Ludwig, and Heinz Ewald (Technische Hochschule, Munich). Z. Naturforsch., 18a: 1288-95(Dec. 1963). (In German)

A double receiver system, which contained a specially prepared double multiplier, was tested on a mass spectrometer. With it comparisons could be made of the isotope frequency ratio Sr^{87}/Sr^{86} in strontium samples of various origins with a relative exactness of 0.2 to 0.5%. It was assumed that the careful, reproducible adjustment for the comparison of mass lines 86 and 87 is also necessary for measurements of lines 87 and 88 at the slit of the receiver system. (tr-auth)

Industrial Applications

Refer also to abstract 13446.

14296 (CONF-187-77) BETA RADIATION PROCESSING AT RIGOROUS CONDITIONS. P. M. Yavorsky and E. Gorin (Consolidation Coal Co., Library, Penna.). Nov. 15, 1963. Contract AT(30-1)-2978. 12p.

From American Nuclear Society Meeting, New York, Nov. 1963.

An investigation was conducted on the impossible use of beta radiation to promote chemical reactions at high temperatures and pressures. The advantages of beta sources over other radiation sources are enumerated. A radiation processing apparatus is described which allows operations to 10,000 psi and 500°C and uses 90 C of $Sr^{90}-Y^{90}$. The dosimetry of the source was accomplished with an iodine–heptane system, and the mean dose rate within the chemical reactor was determined to be 0.98×10^6 rad/hr. The radiation utilization efficiency in the dosimetry measurements was determined to be 34.7%. Results of runs on hydrogenation of coal extract indicate that radiation does not increase the extent of hydrogenation, but that radiation reduces the content of hetero atoms N and S in the 100 × 400°C boiling oil products. The use of beta radiation in the hydrorefining of oils is suggested. (D.L.C.)

14297 (NP-tr-1109) TESTING THE DISTRIBUTION OF ALUMINIUM IN STEEL BY MEANS OF RADIOISOTOPES. J. Fodor, T. József, and T. Makrai. Translated by H. E. Nowottny (U.K.A.E.A. Research Group, Atomic Energy Research Establishment, Harwell, Berks, Eng.), from Isotopen Tech., 83-5(1962). 7p.

The radioactive tracer method was used in the investigation of the aluminium distribution in steel ingots and in sheet produced from these ingots. The distribution of aluminium in the ingot and sheet was found to be continuous and cannot therefore be responsible for "layer formation" in the sheet. The aluminium distribution in the ingot and sheet appears to have the character of the distribution of oxide or sulfide inclusions. The technique used for introducing the aluminium ensures its distribution among the several ingots of the same casting plate with a scatter of ±10%. (auth)

14298 THE ELECTROTECHNICAL INDUSTRY AND APPLICATION OF RADIOISOTOPES. Jean Perette (Euratom, [Brussels]). Assoc. Belge Develop. Pacifique Energie At., Bull. Inform., 8: Nos. 45-46, 30-3(Oct. 1963). (In French)

Two very different aspects of the relations of the electrical industry with the applications of radioisotopes are discussed briefly. The first topic discussed is the utilization of radioisotopes in the electrical and electronic industries, such as radiation treatment of polythene to be used as cables, fabrication of semiconductors, and quality control of electrical components. The contribution of the

electrical and electronic industries to the development of the utilization of radioisotopes is the second aspect discussed. In this area, the design and construction of detection apparatus, only slightly modified from standard devices, and the construction of special devices for industrial uses, e.g., thickness gages and density gages, are cited. The difficulties in the design and construction of special measurement apparatus are indicated. (J.S.R.)

14299 THE USE OF RADIOISOTOPES IN FERROUS METALLURGY. André Kohn. Assoc. Belge Develop. Pacifique Energie At., Bull. Inform., 8: Nos. 45-46, 34-9 (Oct. 1963). (In French)

The use of radioisotopes in metallurgy as tracers and as radiation sources is briefly illustrated. The study of the descent of the charge to the blast furnace, determination of the origin of inclusions, and study of convection currents in ingots during solidification are given as examples of the use of tracers. Control apparatus described include gammagraphs, thickness gages, devices to measure charge level, device to study wear of blast furnace walls, core sample analyzer, and humidity gage. (J.S.R.)

14300 THE IMPORTANCE OF RADIOACTIVE MATERIALS FOR RESEARCH AND TECHNIQUES IN THE CHEMICAL AND PHARMACEUTICAL INDUSTRIES. Hans Gotte. Assoc. Belge Develop. Pacifique Energie At., Bull. Inform., 8: Nos. 45-46, 40-7(Oct. 1963). (In French)

The properties of radioisotopes that make them valuable for use in the chemical and pharmaceutical industries are briefly reviewed. The utilization of tracers in petroleum cracking, manufacture of nitric acid, and study of mixing and dilution processes is illustrated. The applicability of tracer techniques to analytical and biological chemistry, especially with the Hevesy and Paneth method, is discussed. The economic advantages offered by the use of radioisotopes in the chemical and pharmaceutical industries are indicated. (J.S.R.)

14301 RADIOISOTOPES AND THE TEXTILE INDUSTRY. Maurice Robinet. Assoc. Belge Develop. Pacifique Energie At., Bull. Inform., 8: Nos. 45-46, 48-53(Oct. 1963). (In French)

The use of radioisotopes as tracers and radiation sources in the textile industry is illustrated with several examples. Tracers can be used to determine the dyeing mechanism, to follow the formation of synthetic fibers, to control color purity, and in drawing fibers. Radiation can be used to eliminate static electricity, to measure thicknesses of fibers, sheets, and tapes, and to modify the properties of the textile. (J.S.R.)

14302 NUCLEAR ENERGY IN AGRICULTURE AND THE FOOD INDUSTRY. Fernand Van Hoeck. Assoc. Belge Develop. Pacifique Energie At., Bull. Inform., 8: Nos. 45-46, 58-63(Oct. 1963). (In French)

Radioisotopes are used in agricultural research in soil studies, study of vegetable physiology, vegetable pathology, and entomology. Radiation is used by the geneticist and breeder in attempts to improve food plants. It is also used to sterilize harmful insects. Studies on food preservation by radiation were at first unsuccessful, but the first products treated by radiation are now becoming commercially available. (J.S.R.)

14303 RADIOACTIVE TRACERS IN HYDROLOGY. J. N. Svasek. Assoc. Belge Develop. Pacifique Energie At., Bull. Inform., 8: Nos. 45-46, 64-7(Oct. 1963). (In French)

The tracer study of the movement of sediment and sands and its economic value are briefly discussed. The difficulties inherent in all tracer techniques for such investigations are described in some detail. (J.S.R.)

14304 THE PRESENT AND FUTURE RESEARCH PROBLEMS IN THE REGION OF INDUSTRIAL APPLICATIONS OF RADIOISOTOPES. R. Cornuet. Assoc. Belge Develop. Pacifique Energie At., Bull. Inform., 8: Nos. 45-46, 93-?(Oct. 1963). (In French)

The problems encountered in the preparation and execution of research programs on radioisotopes are defined by reference to the experience acquired in France. The type of research programs set up such as possible uses of tracers, low-intensity radiation, activation analysis, and intense radiation sources, are indicated. The future problems to be solved in the regions of technology, safety, and dissemination of information are discussed. (J.S.R.)

14305 ON THE SELECTION OF A RADIOISOTOPE FOR USE IN MEASURING THE SPECIFIC GRAVITY OF WATER VAPOR CIRCULATING IN A SCREEN TUBE OF AN INDUSTRIAL BOILER. Claude Maille, Henri Ader, Daniel Blanc, Joseph Casanovas, and Jacques Fontan (Société Stein et Roubaix, Paris and Faculté des Sciences, Toulouse). Compt. Rend., 258: 481-2(Jan. 13, 1964). (In French)

A method was developed for measuring the specific gravity of the water-steam mixture in boiler tubes by measuring externally the activity from a radioisotope dissolved in the boiler water. Sm^{153} and Cr^{51} appear to be suitable for use in systems, the waters of which exclude and contain, respectively, sodium phosphate. (D.C.W.)

14306 A RAPID METHOD FOR MEASURING THE KIND AND THE ACTIVITY OF EMITTERS USED IN FLAW DETERMINATIONS. František Khol (State Defectoscopic Center, Prague). Jaderná Energie, 9: 331-2(Oct. 1963). (In Czech)

For the detection of flaws in weldments on an industrial scale, Co^{60}, Cs^{137}, Ir^{192}, and Ra^{226} γ sources are currently in use in Czechoslovakia. The activity of these sources usually ranges from 250 mC to 25 C, reaching values of several hundred curies in some cases. Various government regulations require that the nature and the level of the sources used be determined. A rapid method was developed for identifying the sources on the basis of the Pb shield required to attenuate the radiation intensity, expressed in r/hr, to one-half of its original value. From the half life, the Ra equivalent, and half value thickness, a dosimetric constant was derived. The formula obtained allows the exposure times needed under the given operating conditions to be determined quickly. (TTT)

14307 BIOCHEMICAL BASIS OF THE USE OF γ-RAYS TO EXTEND THE STORAGE LIFE OF POTATOES. B. A. Rubin and L. V. Metlitsky (Inst. of Biochemistry, Moscow). Proc. Intern. Congr. Biochem., 5th, Moscow, 1961, 161-7 (1963).

Mechanisms of radioinduced sprout-inhibition were studied. Tuber growth was found to be depressed by gamma doses of 2–3 kr and completely suppressed by 10-kr doses. The chief cause of the growth effect is that meristematic nucleic acid metabolism is affected. Nucleic acid content of the tissue is virtually unaffected by a dose of 10 kr, but the content of the eyes is reduced. The mononucleotides and bases derived by hydrolysis from eye nucleoprotein indicate that the main effect of irradiation is to produce depolymerization. Overtly, the effect of radiation is to cause complete degeneration in the growing points thus inhibiting the ability of the tuber

to produce sprouts. Radiation also produces changes in the redox process associated with sprouting and microorganism resistance. All metabolic changes affect resistance to microorganisms. Hence, the use of gamma rays to prevent sprouting in potatoes will be feasible only if ways can be found to overcome loss of microbial resistance. (H.M.G.)

14308 BIOCHEMICAL PRINCIPLES IN THE APPLICATION OF IONIZING RADIATION IN MEAT TECHNOLOGY. D. N. Rhodes, J. G. Sharp, and M. Ingram (Low Temperature Research Station, Cambridge, Eng.). Proc. Intern. Congr. Biochem., 5th, Moscow, 1961, 217-22(1963).

Properties of mammalian muscle, regarded as meat, considered in treatment with 3–5 Mrad doses are: color, flavor, texture, and nutritive value. Review of data indicates that desirable color is obtained when meat is irradiated anerobically. Restoration of a red color by the radioinduced transformation of metmyoglobin, which proceeds more readily in the absence of oxygen is a desirable reaction. Immediate changes in odor arising mainly from protein degradation are detectable in meat treated with 0.1 Mrad and are seriously objectionable at 5 Mrad. Radiation effects on texture are in the form of softening that is likely related to protein denaturation and reduction in water-binding capacity of the myofibrils. Methods for reducing or eliminating proteolysis in stored meats are considered. Nutritional disturbances caused by irradiated foods mostly proved to be deficiencies originating from vitamin destruction. The gross nutritive value of meat to man was not affected by sterilizing doses, nor was digestibility and biological value of beef protein altered. No obvious toxic effects were observed with pork treated with 2.8 to 5.6 Mrad. (H.M.G.)

14309 FRUIT IRRADIATION—PHYSICAL METHODS. R. J. Romani, Betty J. Robinson, H. L. Rae, E. C. Maxie, and N. F. Sommer. Radiation Botany, 3: 345-50(Dec. 1963).

The control of several treatment parameters is important in the relatively massive dose irradiation of fruit and other biological material. A recently installed cobalt-60 source and salient aspects of dosimetry, dose distribution, temperature and atmospheric control are described. (auth)

14310 NATURAL CARBON-14 ACTIVITY OF ORGANIC SUBSTANCES IN STREAMS. A. A. Rosen (Robert A. Taft Sanitary Engineering Center, Cincinnati) and Meyer Rubin. Science, 143: 1163-4(Mar. 13, 1964).

Carbon-14 measurements made on organic contaminants extracted from streams show percentages of industrial waste and domestic sewage. The method, used previously for studies of the atmosphere, can be used in studies of pollution sources. (auth)

14311 EFFECTS OF GAMMA-RAYS ON WATERMELON HARVEST. A. T. Galka (Dnepropetrovsk Vegetable and Potato Testing Lab., USSR). Vestn. Sel'skokhoz. Nauki, Vses. Akad. Sel'skokhoz. Nauk, No. 8, 53-4(1963). (In Russian)

Irradiation of dry watermelon seed to 25000 r at 317 r per minute promoted sprout growth in some strains and depressed sprouting in others. Four strains of seed sprouted 2 to 3 days earlier than control seed while two strains sprouted 21 days later and eventually died. An analysis of dry substance and harvest proved that 25000-r irradiation is beneficial in certain strains.(R.V.J.)

14312 RADIOACTIVE ISOTOPES IN INSTRUMENTATION AND CONTROL. N. N. Shumilovskii and L. V. Mel'ttser. Translation by R. F. Kelleher of "Osnovy Teoriyi Ustroistv Avtomaticheskogo Kontrolya s Ispol'zovaniyem Radioaktivnykh Izotopov." A Pergamon Press Book. International Series of Monographs on Nuclear Energy. Division IV. Isotopes and Radiation. Volume 3. New York, The Macmillan Company, 1964. 210p. $10.00.

Information is included on types of nuclear radiation, radiation detectors, modulation of nuclear rays, measuring circuits, and errors in measurement; measurement of thickness and density from the absorption of radiation; thickness measurements by radiation backscattering; relay devices; measurement of levels; measurement of flow of liquids; measurement of gas flow; measurement of gas pressure; composition control; and choice of the minimum source activity for the particular dynamic properties of the instruments. 76 references are given. (P.C.H.)

14313 INDUSTRIELLE ANWENDUNG VON RADIOISOTOPEN. VORTRAGE, GEHALTEN ANLASSLICH DER INTERNATIONALEN STUDIENTAGUNG VOM 19/20 SEPTEMBER 1963 IN ZURICH. (Industrial Uses of Radioisotopes. Lectures delivered on the Occasion of the International Study Session, September 19 and 20, 1963, Zurich). [Bern, l'Association Suisse Pour l'Energie Atomique, 1963]. 84p.

Twelve lectures presented at the International Study Session on the Industrial Use of Radioisotopes are given. Separate abstracts were prepared for 8 lectures. Other topics covered include: European market for radioisotopes, French industrial applications of radioisotopes, advantages of uses of radioisotopes in Dutch industry, and the importance of public opinion in the industrial applications of radioisotopes. (M.C.G.)

For abstracts of individual papers see: 13548, 13549, 14314, 14315, 14316, 14317, 14318, and 14319.

14314 THE MARKET FOR INSTRUMENTS. W. Stremme (Frieseke and Hoepfner, Erlangen-Bruck, Ger.). p. 16-20 of "Industrielle Anwendung von Radioisotopen." [Bern, l'Association Suisse Pour l'Energie Atomique, 1963]. (In German)

Instruments used in the industrial application of radioisotopes, the way they work, and the composition of measuring units are described. Most commonly used are thickness and density gages. (auth)

14315 GAMMAGRAPHY (METALLURGY). O. Masi (FIAT, Turin) p.20-4 of "Industrielle Anwendung von Radioisotopen." [Bern, l'Association Suisse Pour l'Energie Atomique, 1963]. (In French)

The role of gammagraphy in the industrial uses of radioisotopes and its application in the metallurgical industry are discussed. The gammagraphical control of material gives the best results when it forms an integral part of a complete control system (destructive and nondestructive). A detailed survey is given of the theoretical principles and the problem of choosing the best radioisotope is discussed. The isotope method is also distinguished from x-ray radiography. The processes in general use are not described but special attention is given to future development. Advances in gammagraphy are considered possible only if the photographic auxiliary equipment also continues to be improved. (auth)

14316 UTILIZATION OF RADIATION: CHEMISTRY UNDER RADIATION, ELIMINATION OF STATIC CHARGES. P. Leveque and R. Hours (CEN, Saclay, France). p.31-6 of "Industrielle Anwendung von Radioisotopen." [Bern,

l'Association Suisse Pour l'Energie Atomique, 1963]. (In French)

Radioisotopes can be used as weak sources of energy; 1 curie of a radioisotope, emitting 1-Mev radiation, represents only 5.92×10^{-9} watt. An estimate of 30 French francs per kwh was made as the cost for a 15-kw installation. It must therefore be used in chemistry for reactions with a high G value or on materials of high molecular weight. As ionization sources they may be used in special cases to eliminate static electricity. Finally, although the radiation-electricity conversion yield is only of the order of 5%, their use for particularly inaccessible sources is foreseen. (auth)

14317 THE USE OF RADIOACTIVE MATERIALS IN ANALYSES AND PROCESS TECHNIQUES. H. Goette (Farbwerke Hoechst AG, Frankfurt-Hoechst, Ger.). p.49-57 of "Industrielle Anwendung von Radioisotopen." [Bern, l'Association Suisse Pour l'Energie Atomique]. (In German)

With the help of radionuclides numerous analytical problems can be treated, which could not be solved before. Three radiometric processes can be distinguished: the Hevesy-Paneth analysis, the isotope-dilution analysis, and the activation analysis. In chemical process control, tracer methods make it possible to follow movements behind nontransparent walls and thus to measure various processes. (auth)

14318 CONTROL OF MIXING PROCESSES, WEAR, AND LEAKAGE BY EMPLOYING RADIOACTIVE TRACERS. Cl. Descamps (Belgo Nucleaire, Brussels). p.58-63 of "Industrielle Anwendung von Radioisotopen." [Bern, l'Association Suisse Pour l'Energie Atomique, 1963]. (In French)

Radioisotopes are widely used for homogeneity studies in mixing of solids or liquids. They are also helpful tools to evaluate the wear of mechanical pieces and to locate leaks. Some theoretical considerations concerning radioisotopes to be used in such problems and the way to work with them are presented. Several industrial applications of radioisotopes related to these different fields are given. (auth)

14319 ORGANIZATION, PERSONNEL, AND LABOR PROBLEMS FOR USE OF RADIOISOTOPES IN INDUSTRIAL OPERATIONS. H.-J. Marcinowski (Geschäftsführer der Isotopen-Studiengesellschaft eV, Frankfurt am Main). p.64-72 of "Industrielle Anwendung von Radioisotopen." [Bern, l'Association Suisse Pour l'Energie Atomique, 1963]. (In German)

In the application of radioisotopes in industry there are a large number of other aspects to be considered besides the primary technical and scientific problems. Finding the optimal place and time for the application of isotopes in the industrial process requires careful consideration. The importance of advance planning of laboratories and departments in which radiation above the tolerated limits is to be used is emphasized. Particular attention should be paid to building materials and design, air conditioning, regulation of the inflow and outflow of air, the problem of radioactive waste, accident prevention, and work place equipment. With regard to the personnel the important thing is the degree of training required. (auth)

14320 RADIATION CONTROL OF SALMONELLAE IN FOOD AND FEED PRODUCTS. Report of a Panel on Irradiation Control of Harmful Organisms Transmitted by Food and Feed Products, with Particular Reference to Salmonellae, Vienna, December 12-14, 1962. (International Atomic Energy Agency, Vienna). Technical Reports Series No. 22. 1963. 151p. (STI/DOC/10/22). $3.00; Sch 63; 18 s.stg; F.fr. 12; DM 10.50 (IAEA).

The epidemiology of salmonellosis in relation to its transmission by food and feed products is reviewed. Technological aspects of the radiation processing of foods for the elimination of Salmonella and other pathogenic organisms are discussed. Separate abstracts were prepared for nine of the papers. (C.H.)

For abstracts of individual papers see: 13397, 13398, 14154, 14321, 14322, 14323, 14324, 14325, and 14326.

14321 SALMONELLAE IN FOODS AND ANIMAL FEEDING STUFFS. B. C. Hobbs (The Food Hygiene Lab. and Central Public Health Lab., London). p.35-52 of "Radiation Control of Salmonellae in Food and Feed Products." Vienna, International Atomic Energy Agency, 1963.

After the problem of Salmonella infections in foods and feeding stuffs is emphasized, an account is given of the current ways of manufacturing bone meal, meat meal, blood meal, fish meal, fish flour, egg products and coconut. The effectiveness in eliminating salmonellae and the chance and possible sources of recontamination are described for each production method. Besides heat treatment, fumigation by ethylene oxide, and irradiation with gamma rays are considered. The bacteriological tests required to establish the effectiveness of treatment are also discussed, as well as the effect of the treatment on the nutritive value of the product. (auth)

14322 MEASURES TAKEN OR RECOMMENDED TO SAFEGUARD IMPORTING COUNTRIES AGAINST COMMODITIES CONTAMINATED WITH SALMONELLA AND SIMILAR ENTEROPATHOGENIC BACTERIA IN RELATION TO THE PROSPECT OF RADIATION CONTROL. D. A. A. Mossel (Central Institute for Nutrition and Food Research T.N.O., Utrecht). p.61-7 of "Radiation Control of Salmonellae in Food and Feed Products." Vienna, International Atomic Energy Agency, 1963.

Bone meal, fish meal, and vegetable products prepared in developing countries are often contaminated with Salmonella and similar enteropathogenic organisms. For prevention of the spread of Salmonella effective measures have to be taken. An attempt is made to review the measures so far taken or suggested for this purpose and to evaluate the prospects for the use of ionizing radiation as a radiation sanitation process. (auth)

14323 REGULATIONS GOVERNING THE CONTROL OF SALMONELLAE IN FEED PRODUCTS IN DENMARK, AND A COMMENT ON THE USE OF RADIATION. Poul-Ivar E. Hansen (Slagteriernes Forskningsinstitut, Roskilde, Denmark). p.73-5 of "Radiation Control of Salmonellae in Food and Feed Products." Vienna, International Atomic Energy Agency, 1963.

The Danish Ministry of Agriculture requires resterilization of all imported meat, bone, blood, and fish meals. At present this sterilization consists of a rather severe heat treatment which leads to a considerable loss in the nutritive value of the products. Irradiation is considered as a promising alternative. It has the advantage that the products will have a higher nutritive value than after heat treatment. This would justify a higher price for the radiation-treated commodities. However, radiation elimination of Salmonella from feeding stuffs is not likely to be more costly than is heat sterilization. (auth)

14324 SALMONELLA CONTAMINATION OF FOODS AND FEEDS AND THE POSSIBILITY OF RADIATION CONTROL IN THAILAND. Lek Tanasugarn (School of Veterinary Medicine, Bangkok, Thailand). p.77-80 of "Radiation Control of Salmonellae in Food and Feed Products." Vienna, International Atomic Energy Agency, 1963.

The prevalence of salmonellae and other harmful microorganisms in egg, poultry and pork is for Thailand a very severe problem, the solution of which would be of great importance to the economy of the country. An attempt was made to use ionizing radiation for rendering chicken meat free of Salmonella. A dose of not less than 50 000 rad was required. (auth)

14325 MICROBIOLOGICAL ASPECTS OF THE USE OF RADIATION FOR THE ELIMINATION OF SALMONELLAE FROM FOODS AND FEEDING STUFFS. Margaret J. Thornley (Low Temperature Research Station, Cambridge, Eng.). p.81-106 of "Radiation Control of Salmonellae in Food and Feed Products." Vienna, International Atomic Energy Agency, 1963.

Before considering the specialized application of irradiation to the elimination of salmonellae and other pathogenes, its relation to other food irradiation processes such as sterilization and pasteurization is outlined. The radiation dose required can be estimated by determination of the D_{10}-values for the organisms, which can be calculated by means of either the end-point method or the survival-curve method. From the D_{10}-values one is able to calculate the dose which will provide any desired degree of inactivation. The effect during irradiation of environmental factors, such as oxygen, freezing, drying and various food constituents, is discussed. The radioresistance of different Salmonella serotypes can vary with the nature and physical state of the product, and the dose needed must be determined in each case. A comparison is made between irradiation, heat treatment and gaseous sterilization. Those three procedures could be used for the elimination of salmonellae. (auth)

14326 TECHNOLOGICAL ASPECTS OF FOOD IRRADIATION WITH PARTICULAR REFERENCE TO SALMONELLAE ELIMINATION. F. J. Ley (Atomic Energy Research Establishment, Wantage, Berks, Eng.). p.107-20 of "Radiation Control of Salmonellae in Food and Feed Products." Vienna, International Atomic Energy Agency, 1963.

The properties and sources of gamma rays and electrons for the treatment of food are reviewed. The dose requirement for the adequate elimination of salmonellae varies with the particular food product in question but is on the order of 0.5 Mrad. At this dose level most foods are not appreciably changed in quality. Significant losses of vitamins do not occur, and the protein value of the product is not changed. Radiation processing seems technologically feasible for the purpose of salmonellae elimination in food and feed products. High capital costs are involved in the establishment of a radiation plant. For instance, the total investment involved in a Co^{60}-plant designed to process 13 000 tons of frozen horse meat per annum at a dose of 0.65 Mrad would be approximately £250 000, most of it being the purchase of the isotope. Allowing for the replacement of the cobalt and based on a ten-year amortization for the plant itself, the cost for the treatment would be approximately 0.56d per pound. In view of the lack of technological development in many countries producing foods and feeds, it seems likely that the first irradiation plant will be installed at an import center. (auth)

14327 INDUSTRIAL USES OF LARGE RADIATION SOURCES. VOL. II. Proceedings of a Conference on the Application of Large Radiation Sources in Industry Held in Salzburg, 27-31 May 1963. (International Atomic Energy Agency, Vienna). Proceedings Series. Nov. 1963. 332p. (STI/PUB/75(Vol.II)) $7.00; Sch 147,-; 42s.stg; F.fr.28,-; DM 24,50(IAEA).

Fifteen papers and a panel discussion (economic aspects of the use of large radiation sources in industry) presented at the Conference on the Application of Large Radiation Sources in Industry are given in this volume. Separate abstracts were prepared for 6 papers. The remaining 9 papers were previously abstracted for NSA. (M.C.G.)

For abstracts of individual papers see: 13559, 13560, 13896, 14328, 14329, and 14334.

14328 THE DOW ETHYL BROMIDE PROCESS: AN INDUSTRIAL APPLICATION OF RADIATION CHEMISTRY. D. E. Harmer, J. S. Beale, C. T. Pumpelly, and B. W. Wilkinson (Dow Chemical Co., Midland, Mich.). p.205-30 of "Industrial Uses of Large Radiation Sources. Vol. II." Vienna, International Atomic Energy Agency, 1963.

Beginning in March 1963, the Dow Chemical Company started manufacturing its entire production of the organic chemical, ethyl bromide, by a process in which the addition of hydrogen bromide to ethylene is induced by a source of gamma radiation. This process constitutes a competitive, commercial use of 1800 curies of Co^{60} as the reaction initiator. Drawings and photographs of this production plant are presented, and radiation yields are given. Experiences gained during the actual start-up of this process unit are discussed. (auth)

14329 EXPERIENCE IN OPERATING LARGE GAMMA-RADIATION INSTALLATIONS. S. Jefferson (Atomic Energy Research Establishment, Wantage, Berks, Eng.). p.231-41 of "Industrial Uses of Large Radiation Sources. Vol. II." Vienna, International Atomic Energy Agency, 1963.

The Spent Fuel Element Pond at Harwell was built to provide a multi-megacurie source of gamma radiation using the spent fuel elements of DIDO and PLUTO. The materials which were processed included medical equipment on pilot and production scales, polyethylene insulation, mechanical rigs for long-term irradiation of lubricating oils, and a wide range of experimental samples. The handling and distribution of the spent fuel elements in the pond included considerations of criticality, contamination, and heat dissipation. The decay of the short-lived components of the gross fission products in the fuel elements entails frequent radiation dose level measurements. When high efficiency of radiation utilization and good uniformity of dosage are required, the materials are rearranged during treatment. The gamma radiation processing plant at the Wantage Research Laboratory was designed to provide a wide choice of dose levels of radiation on a semi-production scale. Experience was gained in the treatment of materials for experimental work and in routine irradiations of medical equipment. The safety system for the protection of the staff against accidental irradiation proved simple and effective. The conveyor system that handles individual packages has given some trouble, particularly in the automatic input store that is outside the concrete shield. Both mechanical and acoustic guard systems were developed, which are capable of stopping the conveyors in a fraction of a second. The behavior of metal surfaces in the irradiation chamber was noted; the effects of ozone, humidity, and gamma radiation were

less than expected. The behavior of several lubricants in the irradiation chamber were also noted. (auth)

14330 INDUSTRIAL USES OF LARGE RADIATION SOURCES. VOL. I. Proceedings of a Conference on the Application of Large Radiation Sources in Industry Held in Salzburg, 27-31 May 1963. (International Atomic Energy Agency, Vienna). Proceedings Series. Nov. 1963. 428p. (STI/PUB/75(Vol.I)). $8.50; Sch 178.50; 51s.stg; F.fr.34,-; DM 29.75(IAEA).

Twenty-five papers presented at the Conference on the Application of Large Radiation Sources in Industry are given in this volume. Separate abstracts were prepared for 9 papers. The remaining 16 papers were previously abstracted for NSA. (M.C.G.)

For abstracts of individual papers see: 13558, 13899, 13900, 13901, 13903, 13904, 13905, 13906, and 14331.

14331 TECHNICAL DEVELOPMENTS IN THE USAEC PROCESS RADIATION DEVELOPMENT PROGRAM. J. E. Machurek and M. H. Stein (Atomic Energy Commission, Washington, D. C.). p.15-39 of "Industrial Uses of Large Radiation Sources. Vol. I." Vienna, International Atomic Energy Agency, 1963.

A broad range of researches was undertaken in the USAEC Process radiation development program. Results of fourteen of these investigations are reported. The subjects included are: preparation of wood-plastic combinations using gamma radiation to induce polymerization; use of fission-product beta radiation for the hydrogenation of coal and coal products to produce liquid hydrocarbon fuels; production of semiconductor devices with the formation of predetermined spacial distribution impurity patterns via neutron transmutation doping; radioinduced polymerization of ethylene and copolymers; basic studies in radioinduced reaction mechanisms and kinetics; radiation chemistry involved in the fluorination of various aromatic compounds; use of polyfunctional monomers for enhanced radiation cross-linking of polyethylene, polypropylene, polyisobutylene, and cellulose acetate; effects of swelling, strain, and temperature on the physical and chemical properties of radiation-produced polymers; radioinduced changes in polymers leading to graft copolymerization as influenced by structural factors; utilization of nuclear radiation for the modification of textile materials; radioinduced reactions utilizing Kr^{85}; preparation of a "Radiation Handbook"; use of the organometallic bond in high level gamma radiation dosimetry; and development of a solar cell dosimeter. (auth)

Power Application

Refer also to abstract 15598.

14332 (NYO-10463) DEVELOPMENT TECHNIQUES FOR POWER PRODUCTION FROM MIXED FISSION PRODUCTS. Phase II Final Report. E. J. Lemanski (General Instrument Corp. Thermoelectric Div., Newark, N. J.). June 1963. Contract AT(30-1)-2605. 98p.

During Phase II, the investigation and analytical studies of Phase I were extended into areas requiring technological development, namely, consolidation and encapsulation of synthetic ICPP (Idaho Chemical Processing Plant) fuel wastes and thermoelectric generator assembly techniques. In addition, analyses were made to determine the size of potential hardware. Based on these analyses, a full scale thermal mockup of an MFP (Mixed Fission Product) generator complete with thermoelectric converter, was built, and testing was initiated. A summary is presented of the results of the fuel consolidation developments whereby synthetic calcined wastes, nominally 1.0 g/cc, were densified via various milling, compacting, fluxing, and sintering methods to yield material of up to 2.6 g/cc. In addition, results are summarized of tests in which bonded assemblies of bismuth telluride were life tested up to 3000 hours at 350-400°F hot junction temperature. Developments in the AEC's waste consolidation program, insofar as they are related to this program as a potential source for MFP fuel, are reviewed. The analytical design of a 3 watt (electrical) undersea thermoelectric generator was completed. A container for encapsulating ICPP type consolidated waste material into a fuel source suitable for an undersea application was designed. Without shielding, the complete generator package would be contained in a 40 inch diameter sphere. An eight inch lead shield would limit the dose level to 10 mr/hr at 3 feet from the fuel centerline. Insulation studies aimed at determining the thermal conductivity of various insulations with different fill gases under reduced pressures were conducted. The thermal insulation properties of opacified aerogel powder were found to improve up to a factor of 10 at reduced pressures. The construction of the electrically heated test generator, including the analytical design and construction of components of the thermoelectric converter is reviewed. Test data are summarized and calculations are presented to amplify the test results. An evaluation of the extended life performance of the thermoelectric converter shows that no measurable degradation has occurred over 2400 hours of operation. The test generator itself demonstrated the concept of using a diffuse heat source for power generation. Continued operation at design temperatures with an overall efficiency of 4% was recorded. (auth)

14333 THERMIONIC ISOTOPE BATTERIES. J. Euler. Atomkernenergie, 9: 64-7(Jan.-Feb. 1964). (In German).

Contrary to thermoelectric isotope batteries, the high surface temperatures required for the operation of thermionic cells cannot be obtained by β emitters but only by certain α emitters, such as Po^{210} or Cm^{242}. The reason is that the energy density of these α emitters is higher by more than a power of ten. Thermionic isotope batteries are considerably lighter than thermoelectric batteries of equal output. The degree of efficiency of both types of batteries is approximately equal, being in the area of 5%. (auth)

14334 PRODUCTION OF STRONTIUM-90 THERMAL POWER SOURCES. J. S. Cochran, J. L. Bloom, and A. Schneider (Martin Co., Baltimore). p.157-72 of "Industrial Uses of Large Radiation Sources. Vol. II." Vienna, International Atomic Energy Agency, 1963.

One of the most attractive fields for utilization of large quantities of waste fission products is the field of direct-conversion power supplies for remote locations. Sr^{90} is being given the greatest exploitation because of its availability, nuclear properties, and the relative ease with which it can be fabricated into compact heat sources. Sr^{90}-fueled generators are being used to power automatic weather stations and navigational aids, and consideration is being given to the use of Sr^{90} as a power source for space vehicles. Evaluation of several potentially useful strontium compounds led to the selection of the titanate as exhibiting overall properties most desirable for this purpose. Sr^{90}, separated from crude fission product streams and purified to the requisite degree, is shipped in the form of the carbonate to a hot cell facility, where

it is converted to titanate pellets. This process is an adaption to remote operation of conventional chemical and ceramic techniques. The pellets are encapsulated in Hastelloy-C containers for use in thermoelectric power supplies. Unusual operational problems are encountered because the large quantities of Sr^{90} handled (potentially millions of curies per year) represent formidable radiation and contamination hazards. Details of the facility, equipment, process, and safety criteria are given. The operational experience gained during the recent processing of the first 250 000 curies of Sr^{90} into fuel for a SNAP-7 generator is described. Encapsulation, calorimetry, decontamination, and waste disposal procedures are also outlined. (auth)

Separation and Production

14335 ELECTROLYTIC SEPARATION OF LITHIUM ISOTOPES IN AQUEOUS SOLUTIONS OF LITHIUM CHLORIDE USING A MERCURY CATHODE. Bengt Collén (Research Inst. of National Defence, Sundbyberg, Sweden). Acta Chem. Scand., 17: 2410-18(1963).

The separation factor, α, for lithium isotopes in the electrolysis of aqueous solutions of lithium chloride at a streaming mercury cathode was investigated as a function of temperature, current density, and electrolyte concentration. The highest separation factor, 1.056 ± 0.004 was obtained in 9.6M LiCl at 5°C at a current density of 0.5 amp/cm^2. From the temperature coefficient of the separation factor in 9.6M LiCl, a difference in activation energy of about −75 cal/mole was found. (auth)

14336 SEPARATION OF URANIUM ISOTOPES. Michel Pecqueur. Ann. Mines, 11-30(Nov. 1963). (In French)

Descriptions are given of electromagnetic separation, heat diffusion, centrifugation and expansion in nozzles as means of enriching UF^6 gas or liquid to obtain U^{235} and U^{238}. Parameters and techniques for the gas diffusion enrichment process, including equipment, pressure, gas concentration, charge quantity, and barrier pore size were determined. (Rev. Metal Lit., 21: No. 2, Feb. 1964)

14337 THE PRODUCTION OF ARTIFICIAL RADIOISOTOPES. René Constant (Centre d'Etude de l'Energie Nuclaire Mol, Belg.). Assoc. Belge Develop. Pacifique Energie At., Bull. Inform., 8: Nos. 45-46, 18-29(Oct. 1963). (In French)

The role of radioisotopes in research, industry, and medicine is indicated briefly. The three principal methods of producing radioisotopes — neutron irradiation in reactors, charged particle irradiation in accelerators, and recovery of fission products — are described and illustrated. Their economic importance is shown and discussed, principally with respect to Belgium. (J.S.R.)

14338 WILL CANADA STAY ON TOP IN ISOTOPES? Can. Chem. Process., 47: 45-6; 48; 55(May 1963).

A review is presented on the production of radioisotopes in Canada. The radioisotopes produced in Canada are listed, and their applications are discussed. The production of therapy machines and food irradiators is also mentioned. (P.C.H.)

14339 ISOTOPE SEPARATION BY THERMAL DIFFUSION IN TERNARY SYSTEMS. A. J. Howard and W. W. Watson (Yale Univ., New Haven). J. Chem. Phys., 40: 1409-13(Mar. 1, 1964).

The problem of isotope enrichment of the middle component in ternary systems via thermal diffusion is discussed, emphasis being placed on systems where the initial concentration of the middle component is considerably less than that of either end component. The design and operation of a 12-column thermal diffusion apparatus in which 99.99% Ne^{22}, 99.4% Ar^{36}, and 8.0% Ar^{38} isotopic samples were produced is described. The concentration of the midcomponent as a function of an end concentration is found to be adequately described by the Jones-Furry theory. The experimental results suggest suitable techniques for application in similar isotopic enrichment programs. (auth)

14340 PROBLEMS IN ELECTROLYTICAL SECONDARY STANDARDIZATION OF Co^{60} PLANE SOURCES. [PART] II. J. Flachowsky (Institut für Angewandte Radioaktivät, Leipzig). Kernenergie, 7: 34-7(Jan. 1964). (In German)

A study was made on a special example of the electrolytic separation of Co^{60} to show under what conditions it is possible to use the amount of current flowing during electrolysis in order to determine the activity. The apparatus is described and the dependence of the current output on the electrolytic conditions is explained. (tr-auth)

14341 A THEORY OF URANIUM ISOTOPE SEPARATION BY TWO PHASE DISTRIBUTION INVOLVING ELECTRON EXCHANGE REACTION. Hidetake Kakihana, Kimiko Kurisu, and Morikazu Hosoe (Tokyo Inst. of Tech.). Nippon Kagaku Zasshi, 84: 784-7(Oct. 1963). (In Japanese)

In a theoretical attempt to find the best separation factor of uranium isotopes, the isotopic effect of electron exchange was considered and a fundamental equation $\ln S = \ln S_2 + \ln \{1 + (S_1 k_e S_2^{-1} - 1/1 + \bar{\rho})\} + \ln \{1 + (k_e^{-1} - 1/1 + \rho)\}$ was obtained where S_1 and S_2 are separation factors for systems having only U(IV) and only U(VI), respectively, k_e is the equilibrium coefficient for the electron exchange reaction between U^{235} and U^{238} in aqueous solution, ρ is the ratio of the concentration of U(VI) and U(IV), and $\bar{\rho}$ represents the second phase. Limiting values for ideal cases are given. Using the values of ρ and $\bar{\rho}$ obtained for systems consisting of hydrochloric acid solution and ion exchange resin, practically attainable separation factors were estimated for cation exchange resin with 2N HCl solution of uranium ($\rho = 4 \sim 9$) and for anion exchange resin with 8N HCl solution of uranium ($\rho = 0.11 \sim 0.25$). (P.C.H.)

14342 RADIOISOTOPES PRODUCTION PROGRAMME AT TROMBAY. H. D. Sharma (Atomic Energy Establishment, Trombay, India). p.379-85 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Radioisotope production in the Apsara and Canada-India reactors is discussed. The laboratory for processing radioisotopes includes an active area for processing, a labeled-compounds hall for preparation of C^{14}-labeled compounds, a small counting room, a laboratory for carrying out developmental work for preparation of radiochemicals, a shielded cell for handling 20-C Co^{60} sources, and an inactive area for offices, health physics room, packing room, dispatch room, and drawing office. Irradiation facilities in the two reactors are described. (M.C.G.)

14343 PRODUCTION OF RADIOISOTOPES IN JAPAN. N. Shibata (Japan Atomic Energy Research Inst., Tokyo). p.387-94 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

The demand for and production of radioisotopes in Japan are discussed. Major facilities for radioisotope production are described. Production of short-lived isotopes, preparation of high specific activity isotopes by the Szilard-Chalmers effect, preparation of isotopes by the (n,p) reaction, and development studies for other nuclide preparation are discussed. (M.C.G.)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 14101 and 14102.

14344 (DP-846) AN ANALOG COMPUTER FOR THE SOLUTION OF LINEAR SIMULTANEOUS EQUATIONS. Robert C. Propst and Robert F. Overman (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Dec. 1963. Contract AT(07-2)-1. 20p.

A desk top computer was designed to solve up to nine simultaneous linear equations rapidly by means of an iterative technique and an oscilloscopic display system. The instrument contains a precision potentiometer, precision resistors, operational amplifiers, and a Zener regulated voltage supply in a DC circuit. An accuracy of 0.2% can be obtained for the solution of the major variable. (auth)

14345 (LA-3026) BODPRO: AN ULTRACENTRIFUGAL BOUNDARY DIAGNOSTIC COMPUTER PROGRAM. P. N. Dean, G. R. Shepherd, and B. J. Noland (Los Alamos Scientific Lab., N. Mex.). Nov. 1963. Contract W-7405-eng-36. 33p.

A computer program was designed for the complete analysis of ultracentrifugal ultraviolet sedimentation boundaries. This Boundary Diagnostic Program (BODPRO) is completely general and is applicable to any sedimentable substance which can produce an ultraviolet boundary in the ultracentrifuge. A listing of the FORTRAN coding for IBM 704 or 7090 computers and examples of a complete operation of the code are included. (C.H.)

14346 (ORNL-3460) THE OAK RIDGE ALGOL COMPILER FOR THE CONTROL DATA CORPORATION 1604. PRELIMINARY PROGRAMMER'S MANUAL. L. L. Bumgarner (Oak Ridge National Lab., Tenn.). Jan. 30, 1964. Contract W-7405-eng-26. 46p.

Descriptions of input-output facilities and details for operation under the monitor system are included. (auth)

14347 (ORNL-3567) MATHEMATICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1963. (Oak Ridge National Lab., Tenn.). Mar. 1964. Contract W-7405-eng-26. 60p.

Research progress in mathematics and programing is summarized, together with the computer programs actually written. Developments in statistical research, applications, and programing are also reviewed. (D.C.W.)

14348 (RTD-TDR-63-3051) PULSED RADIATION EFFECTS ON AEROSPACE DIGITAL COMPUTERS. (International Business Machines Corp. FSD Space Guidance Center, Owego, N. Y.). Oct. 1963. Contract AF29(601)-5399. 217p. (AD-423083)

The results of tests conducted by IBM at the Sandia Pulsed Reactor Facility (SPRF) are reported. Preliminary testing using the IBM flash x-ray machine is described. The tests observe and analyze the behavior of components and circuits used in aerospace digital computers during short, high-intensity nuclear radiation pulses. Several types of burst sensors are compared, and the dosimetry for both the SPRF and flash x-ray radiation environments is discussed. The development and application of computer programing techniques that permit automated digital-computer circuit analysis of the effects of pulsed nuclear radiation on typical aerospace digital computer circuits are reported. Four of these computer programs are presented. (auth)

14349 (TID-20238(Paper 2)) FINITE DIFFERENCE OPERATORS AND NON-LINEAR TRANSFORMATIONS. George S. Handler (Tufts Univ., Medford, Mass.) and John R. Townsend (Pittsburgh. Univ.). 7p.

A method for optimizing a set of finite difference operators is described and is illustrated by calculation of Thomas-Fermi integrals. The technique, particularly suited for computer use, substantially improves the accuracy of the approximate solution with negligible increase in execution time. (auth)

14350 (TID-20257) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. ILLIAC II SYSTEM PROGRAMMING AND OPERATION. PART III. CIRCUIT RESEARCH PROGRAM. PART IV. IBM 7090-1401 SYSTEM. PART V. GENERAL LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital Computer Lab.). Oct. 1963. Contract AT(11-1)-415. 55p.

Component development and testing for the high-speed computer are summarized, together with ILLIAC II operation and programing. The optimum biasing points of Goto pairs were investigated, and the characteristic impedance of a more general strip line than previously considered was calculated. The nonreciprocity relations in ferrites were also studied. Further, some models for microplasma formation were analyzed. Additionally, successful coupling of a laser diode and a photoreceptor through the sides of a Dewar containing liquid nitrogen was achieved. However, inefficiency of the laser and photodiode necessitated use of a very high gain amplifier in the circuits. Sixty-eight problem specifications (described), including twelve instructional problem specifications, were submitted to the IBM-7094. Operation and reliability of the IBM 1401 and IBM-7094 are summarized. (D.C.W.)

14351 (TID-20258) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. ILLIAC II SYSTEM PROGRAMMING AND OPERATION. PART III. CIRCUIT RESEARCH PROGRAM. PART IV. MATHEMATICAL METHODS. PART V. IBM 7090-1401 SYSTEM. PART VI. GENERAL LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital Computer Lab.). Nov. 1963. Contract AT(11-1)-415. 52p.

Upper and lower bounds were established for the impedance of a generalized strip line. An attempt was also made to solve the tunnel diode–transistor interface problem by using a two-transistor negative input impedance circuit, the impedance behavior of which approached that of a tunnel diode. Additionally, initial observations were made on the breakdown characteristics of a microplasma diode. Corrections were made to the Wiener integral evaluation programs FI-17 and FI-21, and five routines were added to the IBM 7094-1401 system. Thirty-nine problem specifications (described), seven of them instructional, were submitted to the IBM 7094. Operation and reliability of the IBM 1401 and 7094 and the ILLIAC II system are summarized, together with ILLIAC II programing and component development and testing in the high-speed computer program. (D.C.W.)

14352 (TID-20307) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. ILLIAC II SYSTEM PROGRAMMING, MAINTENANCE AND OPERATION. PART III. CIRCUIT RESEARCH PROGRAM. PART IV. IBM 7094-1401 SYSTEM. PART V. GENERAL

LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital Computer Lab.). Dec. 1963. Contract AT(11-1)-415. 43p.

A current amplification of about 2000 with a rise time of <2 nsec was obtained using a gallium arsenide lamp-photodiode coupling system and a high-gain transistor amplifer. The best current coupling ratio obtained (photodiode output to lamp input) was 1:7000 at room temperature. Noise problems encountered in experiments on bistable cells using Goto pairs indicate that information storage now presents more problems than the logic. Analysis of microplasma behavior was pursued further. Spurious breakdown caused by the appearance of a carrier capable of ionization presents the most difficulty. Thirty-two problem specifications (described) were submitted to the IBM 7094, including three instructional problem specifications. Component development and testing in the high-speed computer program; ILLIAC II operation and programming; and IBM 1401 and 7094 performance are summarized. (D.C.W.)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstract 15515.

14353 (AD-408310) DESIGN DATA STUDY FOR COATED COLUMBIUM ALLOYS. Bimonthly Report No. 1, March 1, 1963–May 1, 1963. J. D. Gladd and D. B. Warmuth (TAPCO. Div. of Thompson Ramo Wooldridge Inc., Cleveland). June 1, 1963. Contract NOw 63-0471c. 31p. (TM-3710-67)

A brief resume is presented of a design data study of Pfaudler and TRW coated 30 mil FS-85 alloy sheet. The notch sensitivity and influence of the protective coatings on the fracture behavior of this alloy are discussed. Data are presented on the cyclic oxidation to failure of prestrained coated specimens. The design data study for coated niobium alloys is discussed in terms of the mechanical properties which will be evaluated, the evaluation techniques, and the proposed modifications of previously utilized test methods. Mechanical properties of four coating-base metal systems involving the Pfaudler and TRW coatings applied to X-110 (Cb–10W–1ZR) and B-66 (Cb–5Mo–5V–1Zr) alloys will be investigated. (auth)

14354 (ARF-B215-12) STRESS-DEPENDENT INTERACTIONS BETWEEN CESIUM AND OTHER MATERIALS. Summary Report, February 15, 1962–February 15, 1963. David W. Levinson (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Mar. 22, 1963. Contract Nonr 3441(00). 55p. (AD-401666)

Metals and alloys germane to thermionic energy converter usage were screened for embrittlement by liquid cesium. Techniques are described for more detailed studies of ceramics and susceptible metals. Definite reductions in tensile ductility were observed for 302 stainless steel and molybdenum. Bend ductility was lowered in titanium, titanium-6 aluminum-4 vanadium alloy, niobium, tantalum, and silver–copper eutectic solder. Some difficulty in reproducibly wetting samples was evident. Slightly contaminating the cesium with oxygen (or water) was observed to increase cesium wettability. (auth)

14355 (CONF-373-7) THE CONTAMINATION OF REFRACTORY METALS IN VACUA BELOW 10^{-6} TORR. H. Inouye (Oak Ridge National Lab., Tenn.). [nd]. Contract [W-7405-eng-26]. 16p.

From Technical Conference on Applied Aspects of Refractory Metals, Los Angeles, Dec. 1963.

The contamination characteristics of Cb–1% Zr, Cb, Mo, TZM, and Ta by the residual gases in vacua of 10^{-7} to 10^{-6} torr and temperatures of 600 to 1200°C were determined for times up to 1000 hr. The principal contaminant was oxygen and to a lesser degree carbon. Under certain conditions, decarburization and purification occurred. The degree of contamination was largely dependent on the alloy base and was significantly increased by zirconium and/or titanium alloying additions. The reactivity of these alloys decreased in the order Cb–1% Zr, TZM, Cb, Ta, and Mo. For the Cb–1% Zr alloy, contamination was found to increase with temperature, vary inversely as the specimen thickness, while its dependence on system pressure and exposure time was not clearly established. The permissible pressures for negligible contamination are estimated to be below 10^{-7} torr. This pressure can be increased to at least 10^{-6} torr by wrapping the alloy with refractory metal foils. The function of the foils was to serve as a barrier and not a "getter" since the protectiveness of the foils did not depend on their reactivity. Low pressure CH_4 showed promise in controlling oxygen contamination in some of the alloys. (auth)

14356 (EUR-471.f) ETUDE DE LA MISE EN FORME ET DE L'IRRADIATION DU MONOCARBURE D'URANIUM. (Study on the Shaping and Irradiation of Uranium Monocarbide). B. Mansard, P. Rousset (France. Commissariat à l'Énergie Atomique, Paris); J. Herenguel, M. Lamotte, and D. Whitman (Tréfileries et Laminoirs du Havre, France). 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 033-60-12 RDF. 45p. (EURAEC-496)

An investigation was conducted to gather experimental knowledge and technological information on the in-pile behavior of uranium carbide, considered as a nuclear fuel, and to investigate a method of shaping by reaction extrusion. It was possible to carry out a single irradiation of a cartridge containing natural uranium carbide, with 4.6% carbon, in the form of rings and prepared by reaction sintering under pressure, at an average flux of 3×10^{13} n/cm^2 sec for 89 days at a temperature of 500-600°C, the burnup attaining 700 Mwd/t. Under these experimental conditions the uranium-carbide behavior was entirely satisfactory. Hot-state fission-gas extraction tests were carried out on small uranium–carbide samples of the "pencil lead" type after irradiation in the EL-2 reactor. The results show the apparent diffusion coefficient of pressure-sintered uranium carbide to be slightly lower than that of UO_2. The work done on the reaction-extrusion study revealed that whereas it is possible to obtain dense uranium-carbide products at carbon contents of up to 3%, it is much more difficult to reach high densities at near-stoichiometric contents. (auth)

14357 (EURAEC-79) EMPLOYMENT OF PLUTONIUM AS A FUEL IN NUCLEAR REACTORS. Quarterly Report No. 2. Annexes to the Quarterly Progress Report, October 15–December 31, 1960. (Centre d'Étude l'Énergie Nucléaire, Brussels and Société Belge pour l'Industrie Nucléaire, Brussels). Jan. 1961. Work Performed under United States–Euratom Joint Research and Development Program. Contract 027-60-7-RDB. 27p. (BN-610-01)

Progress made in the development of ceramic fuels is reported. Information is included on: fabrication of ceramic fuels by vibration and swaging, preparation and properties of plutonium dioxide-uranium dioxide fuels, fabrication of dispersed fuels by swaging, thermal expansion of uranium dioxide, and mechanical and corrosive properties of niobium–zirconium alloys. (N.W.R.)

14358 (EURAEC-135) EXAMINATION OF ZrNbSn ALLOYS WITH A VIEW TO THEIR USE AS CLADDING IN WATER-COOLED NUCLEAR REACTORS. Quarterly Report No. 1 (2nd Year), April 1, 1961–June 30, 1961. W. Jung-Koenig, H. Richter, P. Wincierz, and U. Zwicker (Metallgesellschaft A. G., Frankfurt am Main). July 5, 1961. Work Performed under United States–Euratom Joint Research and Development Program. Contract 047-61-4RDA. 35p.

As part of a more thorough test program on the behavior of the $ZrNb_2Sn_1$ alloy, a start was made with the examination of the composition of ZrNbSn alloys. Alloys with various niobium and tin contents were produced by melting and used to determine the equilibrium phases by

metallographic and x-ray methods. Corrosion tests in hot water and steam are being used to explain the effects of slight deviations from the nominal composition of the $ZrNb_3Sn_1$ alloy. Corrosion tests on alloys containing niobium and tin, in which a test period of 2000 hours at 480°C was attained, showed the superiority of such alloys compared with Zircaloy-2. In tests designed to establish the appropriate heat treatment, it proved possible, by means of hardness measurements and corrosion tests, to define annealing temperatures and times suitable for softening and for obtaining satisfactory resistance. Subsequent cold working does not after test times of up to 1387 hours, impair the good corrosion behavior of the $ZrNb_3Sn_1$ alloy. The cold-worked $ZrNb_3Sn_1$ specimens show a distinctly smaller weight increase than Zircaloy-2 specimens cold-worked in the same way. For the purpose of examining the influence of the processing technique on corrosion and fatigue behavior, cast-iron slugs of $ZrNb_3Sn_1$ alloy were smelted. A start was made with the examination of the effect of a hydrogen content on fatigue behavior. Hydrogen absorption tests carried out on Zircaloy-2, $ZrNb_2$, and $ZrNb_3Sn_1$ samples showed that hydrogen absorption is possible at final annealing temperatures. The hydrogen absorption takes place more slowly in $ZrNb_3Sn_1$ alloy than in Zircaloy-2. (auth)

14359 (EURAEC-136) TESTING ALLOYS OF ZIRCONIUM WITH NIOBIUM AND/OR SILICON WITH A VIEW TO THEIR USE AS CLADDING MATERIAL IN WATER-COOLED NUCLEAR REACTORS. Quarterly Report No. 5, April 1, 1961–June 30, 1961. W. Jung-Koenig, H. Richter, and U. Zwicker (Metallgesellschaft A. G., Frankfurt am Main). July 6, 1961. Work Performed under United States–Euratom Joint Research and Development Program. Contract EUR/C/262/2/60 e. 30p.

Experiments were conducted to determine the influence of various heat treatments on length variations brought about by thermal cycling. The results of these tests showed that the shrinkage observed in extrusion-hardened Zircaloy-2 and $ZrNb_3Sn_1$ tube sections can be avoided by annealing for one hour at 575°C. The fatigue tests on the alloys Zircaloy-2 and $ZrNb_2$ were completed. Comparison of the results with those hitherto obtained for the alloy $ZrNb_3Sn_1$ confirm the superiority of alloy containing Nb. The alloy $ZrNb_3Sn_1$ in particular has a considerably better fatigue behavior than Zircaloy-2, even when subjected to thermal treatment which is unfavorable to the fatigue behavior but favorable to the corrosion behavior. (auth)

14360 (EURAEC-199) SECOND QUARTERLY REPORT [ON ALLOYS OF Zr WITH Nb AND Sn], JULY 1, 1961–SEPTEMBER 30, 1961. (Metallgesellschaft A. G., Frankfurt am Main). Oct. 20, 1961. Work Performed under Unites States–Euratom Joint Research and Development Program. Contract 047-61-4 RDA. 97p. (Includes original, 32p.).

A test of the constitution of ZrNbSn alloys demonstrated that a tin content decreases the solubility of niobium in α-zirconium. Below 590°C, the alloy $ZrNb_3Sn_1$ consists of α_{Zr} solid solutions and the β_{Nb} phase. At higher temperatures, increasing proportions of the β_{Zr} phase are present. Minor changes in the Nb and Sn content of the $ZrNb_3Sn_1$ alloy, during testing times of up to 1000 hours, exert no influence on the corrosion behavior in water at 350°C and steam at 400°C. In steam at 480°C, an increased tin content leads to intensified corrosion attack. Working after final annealing leads to slightly increased corrosion. When determining the influence of final annealing on corrosion behavior, it was found that the annealing treatments must be carried out below 590°C. Fatigue tests on hydrogen-charged samples of $ZrNb_2$, $ZrNb_3Sn_1$, and Zircaloy-2 were begun. Welding tests on the $ZrNb_3Sn_1$ alloy showed that the alloy is weldable by the argon arc process. The hardness and corrosion behavior of the welding samples can be influenced by a subsequent heat treatment. (auth)

14361 (EURAEC-254) SINTERED URANIUM OXIDE, SINTERING TECHNIQUES, BEHAVIOUR UNDER IRRADIATION. Quarterly Report No. 5, October 1–December 31, 1961. (France. Commissariat à l'Énergie Atomique, Paris). Work Performed under United States–Euratom Joint Research and Development Program. Contract 031-60-10-RDF. 79p.

The development of uranium dioxide as a reactor fuel is studied. Information is included on thermal conductivity, sintering, compression, fission gas diffusion, fabrication equipment design and operation, and mechanical properties of uranium dioxides. Attention is also given to the effects of cracked ammonia, dry hydrogen, and wet hydrogen atmospheres on the sinterability of the fuel. The brazing of Zircaloy-2 to stainless steel is discussed. Progress made in the fabrication of the in-pile loops for testing uranium dioxide is reported. (N.W.R.)

14362 (EURAEC-850) PHYSICAL PROPERTIES OF UO_2 SINGLE CRYSTALS. Quarterly Report No. 7, July 1–September 30, 1963. (Centre d'Etude de l'Energie Nucleaire Mol, Belgium). Work Performed under United States–Euratom Joint Research and Development Program. Contract 063-61-10 RDB. 34p. (R-2255)

Preparation of single crystals of UO_2. Several routine preparations have been made. The excess oxygen content in the starting material is measured systematically in order to determine the optimum composition for crystal preparation. Oxidation of single crystals. A thorough study of the kinetics of the oxidation-reduction reaction has been started. Sintering and diffusion experiments. Work has been devoted to the accurate measurement of the necks developed between single crystalline spheres. An adequate method for the plane-parallel removal of layers of about 0.3 micron thickness has been developed. This will enable the future study of self-diffusion of uranium in UO_2. Structural investigations by electron microscopy. Precipitates in quenched crystals of UO_2 have been investigated. The solubility limit of excess oxygen in UO_2 seems to be beyond an O/U ratio of 2.001. Fission tracks near the surface of an electron transparent foil can be fixed at about 300°C (irradiation temperature). This is due to precipitation of oxygen coming from traces of impurities of the inert gas atmosphere present in the irradiation capsule. Thermal conductivity. The formerly used method of heat conduction for measurements at low temperatures has been modified for more reliable results and a gain in time. In order to avoid the thermal losses due to the smallness of the specimen it has been necessary to develop an alternative method for the high temperature measurements. Theoretical study. The strong coupling polaron theory of Pekar has been applied to an exactly soluble model where the electron interacts with a single lattice oscillator. An expression for the ground state energy has been derived. Furthermore, the total momentum is calculated with the same approximation. Thermoelectric power measurements. Measurements of the thermoelectric power of a series of UO_2 crystals with different excess oxygen content have been continued. Two crystals with O/U = 2.11 showed n-type conductivity. Effects of nuclear radiation on electrical conductivity of uranium dioxide. The recovery of the electrical conductivity has been studied after neutron

irradiation in the temperature range from 125 to 1120°K. A pronounced annealing peak has been found around 725°C. The energy of migration of the defects calculated according to Balarin and Zetzsche's method, is equal to 2.5 ev. The most evident explanation for this 2.5 ev process and thus for the recovery stage at 725°C is uranium vacancy or uranium interstitial migration. Moreover, the marked decrease in conductivity after irradiation suggests that the point defects, which trap the holes are uranium vacancies. A complete discussion of the effects of the fission fragment damage on the electrical properties of UO_2 is given. Ultrasonic attenuation studies. Ultrasonic attenuation studies to be carried out on UO_2 are described. It is shown how these measurements may shed some light on the mechanism for electrical conductivity in UO_2. Preliminary results have shown that the specimen preparation has to be improved in order to obtain surfaces of sufficient parallelism. Optical properties. The low temperature device for spectrophotometric measurements is now operating down to liquid nitrogen temperature. The spectrum shows much structure and it is intended to study the behavior of the different peaks as a function of the O/U ratio. Some aspects of optical absorption by small polarons are discussed. (auth)

14363 (GA-4874) STUDIES OF THERMIONIC MATERIALS FOR SPACE POWER APPLICATIONS. Quarterly Progress Report, September 1, 1963–November 30, 1963. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Feb. 28, 1964. Contract NAS3-4165. 92p.

Isostatic-pressing techniques using reversible gels as the pressing medium were studied for improving the uniformity in density and structure of UC–ZrC bodies. Control of powder-size fraction was studied as a means for controlling the pore distribution. Control of the carbon content by thermal treatment in a mixture of H_2 and hydrocarbon was also studied. Near stoichiometric 30 UC–70 ZrC powder was prepared by gas-metal reaction. Assembly of an apparatus for study of the thermochemical vapor-deposition of tungsten is near completion. The vaporization and fission product release rates of a hot-pressed high-density 30 UC–70 ZrC sample were measured from 1800 to 2000°C. A low-pressure gas adsorption apparatus was set up for measuring the true surface area of UC–ZrC samples. The cell used for the study of fission product diffusion through tungsten was fabricated. Samples are being prepared for fuel-clad compatibility and refractory-metal interdiffusion studies. Diffusion-emission studies were made on a rhenium-clad UC sample at 1800°C. The molybdenum pedestal of the loading device of a high-temperature mechanical testing furnace was modified. Thermionic emission microscopy showed that areas of high work function can co-exist with better-emitting UO_2 dispersions on the surface of a W–UO_2 cermet at 1650°C. Life-testing cells for fueled cesium converters using planar, as well as cylindrical fueled emitters were designed. The cylindrical configuration was favored, since a reliable cylindrical cell envelope was developed. (auth)

14364 (HW-70821) ULTRASONIC INSPECTION OF URANIUM BILLETS TO PREDICT COEXTRUSION PERFORMANCE. Gene L. Waldkoetter (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 22, 1961. Contract [AT(45-1)-1350]. 19p.

Excellent agreement between an ultrasonic test for the grain size of a NPR billet and its extrusion characteristics has been demonstrated. Experience has shown that a billet having relatively fine grains near the surface will yield a smoother zirconium surface on the extruded fuel element than billets with larger grain sizes. This test is being used on a routine basis at Hanford to predict the outer zirconium–uranium interface roughness of the NPR fuel elements. The correlation has been nearly one-hundred percent for NIT and I&E billets of a specific fabrication history. Five-megacycle ultrasonic energy is directed through the billet in a transverse path about one-half inch below the surface. The energy is attenuated in proportion to the grain size of the billet in this area. The entire billet is scanned and the results are recorded on a chart. Reference lines on this chart correspond to predicted surface roughness of extruded fuel elements and are used to analyze the test results. The correlation between the test results and photo-macrographs of grain size has been demonstrated. The method and equipment used for the ultrasonic inspection of the billet are described. (auth)

14365 (HW-79766) METALLURGY RESEARCH OPERATION. Quarterly Progress Report, October–December 1963. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 15, 1964. Contract AT(45-1)-1350. 194p.

Progress is reported in the following sections: physical metallurgy, reactor metals research, chemical metallurgy, and materials engineering. Among the topics studied are irradiation effects, corrosion, and materials properties. Separate abstracts were prepared for all of the sections. (D.L.C.)

For abstracts of individual items see: 14366, 14367, 14407, and 14537.

14366 (HW-79766(p.3.1-64)) PHYSICAL METALLURGY. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Neutron Damage to Metals. Radioinduced defects in Mo foils containing various amounts of carbon traces were studied by transmission electron microscopy. The nature of spot defects and dislocation loops in irradiated Mo is discussed. Results of x-ray diffraction measurements of irradiated Mo foils are given. The influence of temperature and strain rate on the yielding and flow of high-purity Mo was studied. Swelling of Irradiated Fissionable Materials. Results are reported of postirradiation examination of high-purity uranium specimens which were annealed after irradiation. The effects of pulse annealing were also studied. Changes in hardness and density of thorium after postirradiation annealing were determined. Studies of annealing with and without irradiation showed that neutron irradiation stabilizes the grains in uranium at 625°C. Plutonium Physical Metallurgy. Basic studies on the properties of high-purity unalloyed and alloyed plutonium include those on phase transformations and stabilizations, steady-state creep characteristics, deformation, and texturing. The use of a plastic coating in plutonium metallography was investigated. (D.L.C.)

14367 (HW-79766(p.6.1-21)) MATERIALS ENGINEERING. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Gas Loop Development. Tests are in progress on insulation for the ATR test section, and results are reported of a pressure drop study of the tensile specimen holder for the ATR gas loop. The feasibility of using an ultrasonic leak detector to locate pinhole leaks in double contained piping with cast Fiberfrax between pipes was investigated briefly. Two stress-rupture curves at 1100 and 1149°C were obtained for Haynes 25 alloy. PRTR Pressure Tubes. The results of in-reactor inspections of Zircaloy-2 pressure tubes and the fretting corrosion behavior of some process channels are discussed. A burst test was conducted on one irradiated tube. Stress-rupture and burst tests were also

conducted on N-reactor steam generator tubes with leaks. N-Reactor Pressure Tubes. The precipitation of hydride in hydrided Zircaloy-2 NPR process tubes is described. Burst tests and brittle fracture tests were carried out on hydrided and nonhydrided tubes and the results compared. (D.L.C.)

14368 (HW-SA-3110) URANIUM DIOXIDE FUTURES. E. A. Evans, D. R. de Halas, and J. A. Christensen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 15, 1963. Contract AT(45-1)-1350. 11p. (CONF-187-102)

From American Nuclear Society Meeting, New York, Nov. 1963.

A survey is presented of the problems involved in the increased use of UO_2 as a power reactor fuel in the future. These problems include fabrication into fuel elements and their performance. (D.L.C.)

14369 (IS-638) HIGH-PURITY CALCIUM. H. A. Wilhelm and O. N. Carlson (Ames Lab., Ames, Iowa). [Apr. 3, 1963]. Contract [W-7405-eng-82]. 28p.

The history of Ca production in America and the evolution of needs for high-purity Ca are reviewed briefly. A distillation apparatus with a capacity of 4 tons/month of purified Ca was set up at Iowa State, and a detailed description of the apparatus and its operation is given. The purity of the recovered Ca and the factors affecting the purity are discussed. The preparation of special high-purity Ca is also considered. (D.L.C.)

14370 (KAPL-M-JOS-2) A DIAMETER GAGE AND EXTENSION MONITORING SYSTEM FOR ELEVATED TEMPERATURE BIAXIAL STRESS TESTING. John Swota, Jr. and Seymour H. Miller (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 18, 1963. Contract W-31-109-eng-52. 17p.

Instrumentation and equipment designed and constructed to measure strain in materials subjected to biaxial loading at elevated temperatures are discussed in some detail. To illustrate the use of the apparatus, sketches of the equipment components are presented along with typical data obtained for zirconium alloys. (auth)

14371 (NAA-SR-8702) COMPATIBILITY OF BORON CARBIDE WITH POTENTIAL AOMR CONTROL ROD CLADDING MATERIALS. R. D. Hahn (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 1, 1964. Contract AT(11-1)-Gen-8. 24p.

The solid state compatibility of boron carbides with commercial copper, Types 304 and 430 stainless steels, and AISI 4130 steel, for potential control rod application, were investigated at 750, 950, 1100, and 1300°F, for periods of 500, 1000, 5000, and 10,000 hr. These studies have shown commercial copper and Type 430 stainless steel to be compatible with boron carbide at 1300°F for 10,000 hr. Type 304 stainless steel was compatible with B_4C for 10,000 hr at 1100°F, but not at 1300°F. There were no reactions observed in the AISI 4130 steel for 10,000 hr at 750°F; but a very hard reaction zone, which increased in width from 1 mil at 950°F to 10 mils at 1300°F, was observed. The phase formed in the AISI 4130 steel was identified, by x-ray diffraction, to be primarily Fe_2B. The activation energy for the growth of this phase was calculated to be about 38 kcal/mole. (auth)

14372 (NMI-2124) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report to United States Atomic Energy Commission for the Month of December 1963. (Nuclear Metals, Inc., West Concord, Mass.). Feb. 28, 1964. Contract AT(30-1)-2784. 66p.

Progress is reported on the extrusion and plug drawing of tungsten and W–Re tubing and on ring-compression tests of the tubing. Preparation of ultrahigh-purity single crystals of beryllium and crystals with 1 wt % Ni is being carried out. Further evaluation of splatcooled U–0.2 wt % Be and of cast Zircaloy-2–1.1 wt % Be was continued. (M.C.G.)

14373 (NP-13498) DESIGN DATA STUDY FOR COATED COLUMBIUM ALLOYS. Bimonthly Report No. 4, September 1, 1963–November 1, 1963. (Thompson Ramo Wooldridge Inc. TRW Electromechanical Div., Cleveland). Dec. 1, 1963. Contract NOw 63-0471c. 54p. (TM-3831-67)

A portion of the mechanical tests of Pfaudler and TRW coated 30 mil B-66 and D-43 niobium alloy sheet is completed. Data are presented from one atmosphere cyclic oxidation tests at 1600, 2000, 2300, and 2600°F. Tensile data for uncoated and coated sheet are reported at room temperature to 2300°F. The tensile behavior of coated B-66 and D-43 alloy sheet is discussed relative to the behavior of uncoated sheet. Preliminary results of creep tests in air at 2000 and 2300°F conducted on coated B-66 and D-43 alloy sheet are presented. (auth)

14374 (ORNL-3523(p.227-75)) INVESTIGATIONS OF MODERATOR MATERIALS. A. Goldman, B. L. Greenstreet, G. M. Watson, and H. W. Savage (Oak Ridge National Lab., Tenn.).

Tests for evaluating graphite as a structural material are reported. The strain-energy data show some interrelation with fracture stress, but they exhibit too much scatter to be useful for estimating strength. Other methods for determining strength are being investigated. The experiment for determining the irradiation creep of AGOT graphite was completed. Studies are being conducted to identify shapes for graphite blocks in which the stresses and distortions associated with irradiation-induced dimensional changes are minimized without sacrificing ability to meet other requirements for a particular application. Results of studies of configurations applicable to the EGCR are presented. A theoretical study is under way of the relative importance of the stress-strain relationships in predicting the behavior of graphite bodies under thermal and externally applied loading. Studies of thick-walled graphite cylinders were extended. A stress analysis was made of the cantilever-beam type of specimen used for determining the in-pile creep of graphite. Measurements of the permeabilities of various nuclear-grade graphites currently in progress include measurements of graphite with uranium carbide admixtures and stratified media. Thermal transpiration data were obtained for argon under two different temperature conditions. Although difficulties were encountered in affixing values to the higher temperatures employed, it was possible to describe the results with existing equations provided characteristic temperatures replaced those actually measured. A program of study of the ordinary binary mutual diffusion of gases was initiated. The single diffusion coefficient determined thus far, for the system helium–argon at 273.2°K and at 1 atm, is in good agreement with values reported previously. The rates of reaction of Speer Moderator-2 graphite with helium–CO_2 mixtures having CO_2 concentrations ranging from 60 to 1650 ppm by volume were measured at 975°C. The same graphite specimen was reacted with helium–H_2O mixtures containing H_2O concentrations between 20 and 760 ppm at temperatures of 825 to 1025°C. Activation energies measured at 110 and 460 ppm of H_2O were found to decrease from approximately 58 to approximately 40 kcal/mole as the temperature was increased from 825 to

1025°C. The most pronounced change occurred near 900°C. Reaction rates calculated from the H_2 and CO contents of the effluent gas were higher than those determined from weight losses of the graphite specimen. The results of a test of the compatibility of graphite and metals in hydrogen were inconclusive because of hydrogen diffusion from the autoclave. Modifications are being made to the apparatus. A loop for studying graphite oxidation and mass transfer at pressures up to 10 psig was placed in operation. The loop has operated 550 hr of a scheduled 1000-hr test at a helium gas pressure of 3 psig and a maximum graphite temperature of 1820°F. A facility for testing the effects of very low concentrations of impurities in high-pressure helium in a simulated gas-cooled power reactor system is nearing completion. Radiation damage is reported for four types of cylindrical BeO specimens of two densities (2.7 and 2.9 g/cm^3) and two grain sizes (~22 and 34 to 72 μ) that were irradiated at 100, 650, and 1100°C to fast-neutron (>1 Mev) doses ranging from 0.3×10^{21} to 4.2×10^{21} neutrons/cm^2. (auth)

14375 (RFP-342) A METHOD OF STRIPPING AND REPLATING NICKEL ELECTROPLATED URANIUM. W. H. Roberts (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). Mar. 9, 1964. Contract AT(29-1)-1106. 8p.

The bulk of development work concerned the resolution of the nickel stripping bath. Borrowing an idea from Canadian Patent 666,198 (for the dissolution of aluminum coatings from uranium fuel rods), an acidic solution was developed to include both a catalytic agent (mercuric nitrate) to accelerate the removal of nickel and an inhibitor (nickelous nitrate) to retard the reaction with uranium. The final formulation of the stripping bath contains 20 g $Hg(NO_3)_2 \cdot H_2O$ and 20 g $Ni(NO_3)_2 \cdot 6H_2O$ in 250 ml HNO_3, 250 ml H_2SO_4, and 500 ml H_2O. Utilization of this solution under prescribed conditions thoroughly strips nickel and simultaneously etches the uranium substrate, allowing immediate replating from a $NiSO_4$ bath without additional etching steps. Freshly machined uranium test coupons, 2 inches long and $\frac{1}{4}$ inch in diameter, were used in the development of the process; no attempt was made to adapt the final process to field specimens of partially corroded fuel elements. (auth)

14376 (SB-409(Suppl.1)) METAL COATINGS. OTS Selective Bibliography, 1960–August 1963. (Office of Technical Services, Washington, D. C.). 44p.

Approximately 750 references to lists, reports, and translations are presented which are arranged under the following headings: electrodeposition, vacuum deposition, spray coatings, plastic coatings on metal, plating, phosphate coatings, anodic coatings, and general. (D.L.C.)

14377 (TID-7676) THE FOURTH URANIUM CARBIDE CONFERENCE, EAST HARTFORD, CONNECTICUT, May 20-21, 1963. (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). 224p.

Twenty papers presented at the Fourth Uranium Carbide Conference are given. Separate abstracts were prepared for 19 of the papers. The remaining paper was previously abstracted for NSA. (M.C.G.)

For abstracts of individual papers see: 13725, 14378, 14379, 14380, 14381, 14382, 14383, 14430, 14431, 14432, 14433, 14434, 14467, 14468, 14469, 14470, 14471, 14541, and 14542.

14378 (TID-7676(p.2-9)) URANIUM AND PLUTONIUM CARBIDE DEVELOPMENTS. AT ARGONNE NATIONAL LABORATORY. T. R. Johnson, G. D. White, O. L. Kruger, R. K. Steunenberg, and J. Handwerk (Argonne National Lab., Ill.).

Uranium and plutonium monocarbides are being studied as possible high-performance fuels for fast-breeder reactors. Synthesis methods are being studied, which can be incorporated into liquid metal processing concepts. UC was prepared by reacting powdered carbon with uranium dissolved in a liquid zinc–magnesium alloy. Plutonium monocarbide, however, will not precipitate when carbon is added to a solution of plutonium in zinc or cadmium. Plutonium sesquicarbide precipitates from high magnesium solutions, and it might be reacted with uranium monocarbide and additional plutonium during retorting to produce a uniform mixture. Fabrication of the carbide powders by cold pressing and sintering is being studied. (M.C.G.)

14379 (TID-7676(p.25-37)) URANIUM CARBIDE DEVELOPMENT PROGRAM AT ATOMICS INTERNATIONAL. W. C. Hayes (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

For use in Atomics International's sodium-graphite power reactors, hypostoichiometric uranium carbide is being developed to be clad with Type-304 stainless steel through a sodium bond. Out-of-pile compatibility studies indicated that the stainless steel cladding is unaffected at least to a temperature of 1600°F. Irradiations were performed at temperatures in excess of 2000°F to burnup near 17,000 Mwd/MTU. An investigation was made of possible barriers to carbon diffusion, which could be used with hyperstoichiometric uranium carbide. Also, experiments were conducted on ternary additions to the UC system, which may stabilize the carbon. Some observations are reviewed on grain growth and plasticity on uranium carbide. (auth)

14380 (TID-7676(p.75-98)) URANIUM–CARBON ALLOYS. SOME RECENT RESEARCH AND DEVELOPMENT STUDIES AT THE COMMISSARIAT A L'ENERGIE ATOMIQUE. A. Accary (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay).

Research and development studies on uranium carbides are summarized. Topics covered include: composition diagram, solid solution of oxygen in monocarbide, mechanisms of phase changes, arc melting, electron-beam melting, and induction melting. (M.C.G.)

14381 (TID-7676(p.163-9)) STUDIES OF ALLOY CARBIDES AT WESTINGHOUSE ASTRONUCLEAR LABORATORY. A. Boltax, C. E. Vogel, and W. D. Allen (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh).

A program is in progress on the development of high-temperature fuel materials consisting of solid solutions of UC and the monocarbides of refractory metals, such as NbC, ZrC, TiC, and TaC. The program is divided into three phases: fabrication of the fuel, general metallurgical studies, and irradiation experiments. Four methods of fuel fabrication were explored: arc melting and casting, cold pressing and sintering, carburization, and hot pressing. (M.C.G.)

14382 (TID-7676(p.183-98)) CARBIDE FUEL DEVELOPMENT AT THE UNITED NUCLEAR CORPORATION. D. Stahl and A. Strasser (United Nuclear Corp. Development Div., White Plains, N. Y.).

A program is being carried out to produce UC–PuC and to obtain data on its irradiation behavior for long burnups and at high power generation rates. Results of out-of-pile

evaluation of various fuel processing techniques, property measurements, and in-pile irradiation of UC, and (U,Pu)C are summarized. (M.C.G.)

14383 (TID-7676(p.199-213)) PROGRESS IN PROPERTY DETERMINATIONS AND FABRICATION OF URANIUM CARBIDE AT UNITED NUCLEAR CORPORATION. J. Crane and E. Gordon (United Nuclear Corp. Development Div., White Plains, N. Y.).

Uranium carbide fabrication development and property studies are described. Powder metallurgy and arc-casting are discussed. Results of thermal expansion measurements and irradiation tests are presented. (M.C.G.)

14384 (USBM-U-1091) QUARTERLY METALLURGICAL PROGRESS REPORT NO. 21 FOR THE PERIOD OF OCTOBER 1–DECEMBER 31, 1963. (Bureau of Mines, Albany Metallurgy Research Center, Ore.). Contract AT(11-1)-599. 30p.

A study of stainless steel–Gd alloys was completed and the 10-wt % Gd isopleth in the Fe–Cr–Gd ternary system investigation progressed. In a program to determine physical and mechanical properties of fused hafnium carbide, evaluation of ingots disclosed that only occasionally could a section of an ingot be found that was neither cracked nor porous. Reaction in air up to 1000°C was determined on selected specimens. The investigation of thorium–rare earth phase diagrams consisted of the determination of solidus temperatures and solid-state transformation temperatures. The construction of a new confined radioactive laboratory was begun during the period. Data on electron beam melting of Zr indicate that O_2 can be removed through "doping" with selected metals. Equipment for study of cold-mold induction melting is now nearly complete. In investigations of UC–UN–UO_2 systems, most of the efforts were devoted to the development of techniques for powder milling and handling and body fabrication. Examination of the high-temperature decomposition characteristics of UN was initiated. Study of the effect of UN additions on the high temperature properties of UC has undergone a reorientation. The project will now consist of an investigation of UC–UN–UO_2 systems. Samples from arc-melted UN evaluated by metallographic examination were two-phase, tentatively identified as U and UN. Loss of weight during the sintering of UN compacts cannot be explained on the basis of decomposition of the compound as the material present is essentially UN. UN melting and casting research has been terminated. Data on the thermodynamics of cold molds indicate that during consumable-electrode arc melting the transfer of heat is distributed over a much larger area than during nonconsumable-electrode arc melting. Isostatically-pressed W-25 Re alloy compacts were sintered in vacuum at 1,800 to 2,750°C. X-ray and microstructure analyses are not complete but preliminary results indicate that sigma phase is present in all specimens sintered at or below 2,200°C. Compacts were upset-forged at 1,400°C. Limited forgeability was observed for compacts sintered at 2,000 and 2,200°C and good forgeability for compacts sintered at or above 2,400°C. Swaging of W and W-25 Re tubes over a Mo mandrel at 1,500°C showed that the short blade, chopper-type swaging dies are superior to the long-blade, general purpose dies. Wall thickness of the tubes remained essentially unchanged when swaged to reduce the outside diameter by 30%. W wires were drawn at 450° to compare lubricants such as oildag, perma-slik, and a sugar-aquadag mixture. All three lubricants were equally satisfactory. Preliminary studies of methods for the preparation of W–Re powder compacts for arc melting and skull casting led to the use of electron-beam equipment for sintering at approximately 2,500°C. Casting experiments will begin as soon as the furnace is complete and a sufficient stock of electrodes is available. (auth)

14385 (EURAEC-114) [PRODUCTION OF UO_2 POWDER]. 2nd Quarter Progress Report, April 1–June 30, 1961. [France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay]. Work Performed under United States–Euratom Joint Research and Development Program. Contract 031-60-10 RDF. 34p. (A translation)

The sinterability of uranium dioxide is studied with respect to its use as a reactor fuel. Progress made in the development of the bench loop and the Medicis loop for irradiation testing of the uranium dioxide fuel is reported. Production of uranium oxide in the rotary reducing furnace is discussed. Fabrication of the fuel in various forms is described along with the techniques used. (N.W.R.)

14386 (EURAEC-822) INVESTIGATIONS ON ZIRCONIUM HYDRIDE IN ZIRCALOY-2 AND ZrNb ALLOYS. Quarterly Report No. 8, July 1 to September 30, 1963. (Siemens-Schuckertwerke A. G., Erlangen, Germany). Work Performed under United States–Euratom Joint Research and Development Program. 42p. (A translation)

The effects of hydrogen content on the mechanical properties of copper–molybdenum–zirconium and copper–niobium–zirconium alloys were determined. The corrosion of Zircaloy-2 and niobium–zirconium alloys by superheated steam at 500°C and pressurized water at 350°C was measured and the uptake of hydrogen from the reactions was determined. Metallographic investigation and comparisons of hydride precipitations in corroded and hydrogenated specimens of copper–molybdenum–zirconium and copper–niobium–zirconium alloys were made. (N.W.R.)

14387 (EURAEC-860) SINTERED URANIUM OXIDE, SINTERING TECHNIQUES, BEHAVIOR UNDER IRRADIATION. Quarterly Report No. 12, July 1–September 30, 1963. (France. Commissariat a l'Energie Atomique, Paris). Work Performed under United States–Euratom Joint Research and Development Program. Contract 031-60-10-RDF. 78p. (A translation)

The thermal conductivity of sintered uranium dioxide is measured before and after irradiation. The properties of uranium dioxide slugs are evaluated in Saclay Reactor (EL-3) with special interest on the thermal conductivity and diffusion of fission gases in the fuel. The first adsorption measurements of radioactive xenon on very small surfaces of glass and uranium dioxide are described. (N.W.R.)

14388 (FTD-TT-63-1012) OBJECTS FROM URANIUM DIOXIDE. P. P. Budnikov, A. S. Berezhnoi (Berezhnoy), et al. Translation of p.396-9 of "Tekhnologiya Keramiki i Ogneuporov" (a publication of Gosstroyiza, Moscow, 1962). 8p.

The occurrence in nature and the properties of UO_2 are reviewed in some detail. The U–O phase diagram and some of the reactions of UO_2 are discussed. Finally, the fabrication of UO_2 into objects by pressing, drawing, etc. is considered. (D.L.C.)

14389 THE FRENCH NUCLEAR INDUSTRY AND REACTOR DEVELOPMENT. THE FRENCH POSITION IN THE REGION OF NUCLEAR MATERIALS AND METALS. J. J. Baron. Atompraxis, 9: 519-23(Nov.-Dec. 1963). (In French)

The problems created by the use of some metals, structural materials, and special materials in reactors are

discussed. The materials considered are aluminum, magnesium, beryllium, zirconium, steels, and graphite. (J.S.R.)

14390 ON THE REDUCTION OF ZIRCONIUM UNDER VACUUM. Gerard Gosse, Louis Renucci, Philippe Albert, and Pierre Lehr. Compt. Rend., 258: 589-91(Jan. 13, 1964). (In French)

The reduction of zirconium in an electron bombardment oven by C, $CaSi_2$, and Al in an attempt to obtain ductile zirconium is described. (tr-auth)

14391 CHROMIUM-5% MAGNESIA FOR HIGH TEMPERATURE SERVICE. W. C. O'Neal (Univ. of California, Livermore). Metal Progr., 85: No. 3, 96-100(Mar. 1964).

The use of Cr–5MgO at high temperatures is discussed. Mechanical properties, oxidation in dry air oxide coatings, fabrication, machining, brazing, spot welding, and nondestructive testing of Cr–5MgO are considered. (P.C.H.)

14392 REACTOR MATERIALS. Volume 6, No. 4. R. W. Dayton, E. M. Simons, and R. W. Endebrock (Battelle Memorial Inst., Columbus, Ohio). 1963-64. 82p. $0.55 (GPO)(Domestic), $0.70(GPO)(Foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC).

Progress in the development of reactor materials is reported. Topics covered include: behavior of fission gases in ceramic reactor materials, fuel and fertile materials, moderator materials, nuclear poisons, cladding and structural materials, and special fabrication techniques. Separate abstracts were prepared for each topic. (M.C.G.)

For abstracts of individual chapters see: 14393, 14394, 14395, 14396, 14446, and 14522.

14393 FUEL AND FERTILE MATERIALS. (Battelle Memorial Inst., Columbus, Ohio). Reactor Mater., 6: No. 4, 11-36(Winter 1963-64).

Research and development progress is reported on uranium, α-uranium alloys, γ-uranium alloys, plutonium alloys, plutonium compounds, thorium, dispersion fuels, cermet fuels, coated-particle fuel materials, refractory fuel and fertile material, corrosion mechanisms for fuel alloys, and radiation effects on fuel materials. (83 references). (M.C.G.)

14394 MODERATOR MATERIALS. (Battelle Memorial Inst., Columbus, Ohio). Reactor Mater., 6: No. 4, 37-50(Winter 1963-64).

Research and development progress on graphite, beryllium, beryllium alloys, beryllium oxides, zirconium hydrides, lithium hydrides, and zirconium-uranium hydrides for use as reactor moderators are reported. (43 references). (M.C.G.)

14395 NUCLEAR POISONS. (Battelle Memorial Inst., Columbus, Ohio). Reactor Mater., 6: No. 4, 51-3(Winter 1963-64).

Research progress is reported on metallic poison materials and dispersion control materials. Hafnium, boron, and rare earth alloys and compounds are considered. (18 references). (M.C.G.)

14396 CLADDING AND STRUCTURAL MATERIALS. (Battelle Memorial Inst., Columbus, Ohio). Reactor Mater., 6: No. 4, 54-69(Winter 1963-64).

Research on corrosion of zirconium, aluminum, stainless steel, iron alloys, nickel alloys, and uncoated refractory materials is described. Corrosion by liquid metals and fused salts is also discussed. Radiation effects on structure and mechanical properties of nonfuel materials are also being studied. Selected mechanical properties and metallurgical aspects of cladding and structural materials are also being investigated. Diffusion studies and research in ceramic technology is also reported. (82 references). (M.C.G.)

14397 PURE TUNGSTEN GRANULES MADE BY GAS REDUCTION. Steel, 153: 102; 105(Nov. 4, 1963).

Hydrogen reduction of WF_6 gas using the fluidized bed process was used to produce high purity tungsten granules from scrap tungsten. Mechanical properties of the granules and parts made from them have improved mechanical properties, which were determined from room temperature to 1500°F. (Rev. Metal Lit., 21: No. 1, Jan. 1964)

14398 INDUCTION ZONE REFINING OF REFRACTORY METALS. O. P. Kolshin, I. K. Berlin, and N. V. Presnetsova. Tsvetn. Metal., No. 9, 59-65(1963). (In Russian)

Description is given of crucible-free induction zone refining in vacuum and in Ar mediums of high purity Ti, Zr, and V in a special device with vertical positioning of the refined specimens. Determination was made of the necessary number of heating passes for each of the specimens to provide for evaporation of C, Si, N, and metallic impurities. (Rev. Metal Lit., 21: No. 1, Jan. 1964)

14399 HIGH-TEMPERATURE INORGANIC COATINGS. John Huminik, Jr., ed. New York, Reinhold Publishing Corporation, 1963. 319p.

Information is included on coating materials and coating systems; structural materials for high-temperature use; methods for applying coatings; testing and evaluation of coatings; designing with coatings; mechanisms operating in coatings; and the future outlook for coatings. (P.C.H.)

Corrosion

14400 (ACNP-64001) PATHFINDER ATOMIC POWER PLANT. CORROSION-EROSION TESTING OF STAINLESS STEEL IN OXYGENATED SATURATED STEAM. C. R. Bergen (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Feb. 10, 1964. For Northern States Power Co., Minneapolis and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. 19p.

An investigation was conducted of the corrosion-erosion characteristics of various stainless steels in dynamic saturated and superheated steam containing oxygen and moisture. The steels studied included types 304, 304L, 316, and 316L. All the alloys suffered some intergranular attack in wet oxygenated steam, and this intergranular attack increased with moisture content in the steam and carbon content in the alloy. Erosion was found for the high-carbon 304 but not for the others. (D.L.C.)

14401 (BNL-7553) MECHANISMS OF LIQUID METAL CORROSION. J. R. Weeks (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 32p. (CONF-428-1)

From National Association of Corrosion Engineers Conference, Kansas City, Mo., Oct. 1963.

Investigations were made on the solubilities of O, H, N, and C impurities and Ni, Cr, and Fe in alkali metals and Bi, Pb, and Hg. Mechanisms for liquid metal corrosion are discussed, and data are tabulated. (P.C.H.)

14402 (CEND-202) CORRELATIONS BETWEEN SENSITIZATION AND STRESS CORROSION CRACKING OF 300 SERIES STAINLESS STEELS. Progress Report for Period Ending December 31, 1963. G. Zuromsky and W. P. Chernock (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). Jan. 1964. Work Performed under

United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3256. 20p. (EURAEC-983)

The morphological changes associated with grain boundary carbide precipitation in Type 304 and Type 347 stainless steels were investigated for two sensitization temperatures (650°C and 928°C). The character and distribution of these carbides should influence the susceptibility of the steels to intergranular corrosion and oxidation. Samples with continuous and discontinuous carbide networks will be included in the program. A decision was made to use a modification of the Bureau of Standards tubular sample with the inside of the tube containing pressurized inert gas to provide controlled strains during test. Assembly of the test facility is nearing completion. (auth)

14403 (CI-221) PRELIMINARY STUDY OF PICK-UP AND RELEASE OF FLUORINE BY ZIRCALOY. K. Beg and F. Brown (Atomic Energy of Canada Ltd., Chalk River, Ont.). July 1962. Reprinted, Feb. 1964. 20p.

Chemical polishing (pickling) of Zircaloy in HNO_3/HF solutions caused attachment of ~0.5 $\mu g/cm^2$ of fluorine. This fluorine was firmly bound and, so far, was only removed by treatment with steam at 500°C (which causes appreciable corrosion of the Zircaloy surface). There was no significant difference in the overall fluorine pick-up during "good" and "bad" pickling. All Zircaloy surfaces picked up 0.1 to 0.2 $\mu g/cm^2$ of fluorine from water containing 5 ppm of fluorine at pH 5.2; a considerable part of this pick-up was readily reversible. (auth)

14404 (EURAEC-95) CORROSION PROBLEMS. Quarterly Progress Report No. 4, December 1, 1960–March 31, 1961. (Centre Belge d'Étude de la Corrosion, Brussels; Centre d'Étude l'Énergie Nucléaire, Brussels; and Société d'Études, de Recherches et d'Applications pour l'Industrie, Brussels). Apr. 1961. Work Performed under United States–Euratom Joint Research and Development Program. 101p.

This report is Book 1, Text.

Potentiodynamic, potentiostatic, and corrosion-measuring studies relating mainly to stainless steels; chronopotentiometric studies dealing mainly with aluminum, aluminum alloys, iron, and zirconium; the preparation of potentiodynamic studies with irradiation in the BR-1 Reactor loop; chronopotentiometric tests with irradiation in the BR-1 Reactor loop; and studies dealing with the preparation and examination of samples are reported. (N.W.R.)

14405 (EURAEC-142) INFLUENCE OF CHLORIDES AND OXIDIZERS ON THE BEHAVIOUR OF STAINLESS STEELS IN BI-CARBONIC SOLUTION. Report No. 725. C. Vanleugenhaghe, L. Klimczak-Mathieu, J. Meunier, and M. Pourbaix (Centre Belge d'Étude de la Corrosion, Brussels). Mar. 1961. Work Performed under United States–Euratom Joint Research and Development Program. 14p.

A study was made of the behavior of AISI 304, 316, and 410 stainless steels in 0.10 M $NaHCO_3$ solutions containing various concentrations of NaCl. In the study, potentiodynamic measurements were made, and the results are expressed in terms of break-through and protective voltages. For a given stainless steel and condition, there is a critical chloride content below which no corrosion can occur, while above it, corrosion occurs in the presence of an oxidizing agent or an electric current which increases the electrode voltage of the steel to above the break-through voltage. However, a stainless steel can be protected against corrosion by a cathodic treatment which reduces the voltage to below the protective voltage. (D.L.C.)

14406 (EURAEC-852) IN-PILE CORROSION OF NUCLEAR MATERIALS. Quarterly Report No. 6, July 1–September 30, 1963. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). Work Performed under United States–Euratom Joint Research and Development Program. Contract 084-62-3-RDB. 21p.

A loop was constructed and loaded into the BR-1 reactor channel $Y_{48}B$. This loop was tested for electrochemical measurements. Two experiments were made in a gamma source, one for potentiodynamic measurements and one for measurements by the single-pulse technique. (E–i) curves were obtained on platinum electrodes in N_2-saturated solutions of $KHCO_3$, KOH, and $(NH_4)HPO_4$. A general increase in oxygen evolution potential was observed. (E–i) curves on stainless steel 316 L in N_2-saturated solution of $KHCO_3$ did not exhibit the increase in oxygen evolution potential. Pitting of stainless steel in KCl solutions was investigated. The number of passivation experiments on one specimen influenced the critical KCl concentration for the onset of pitting. Experiments under gamma irradiation showed that a gamma flux of 3×10^5 R/h during four days had no effect on platinum in a N_2-saturated solution of $KHCO_3$. Also no effect of gamma rays was found in single-pulse measurements on zirconium specimens. In the post-irradiation work it was found that a temperature increase during welding of the irradiation capsules affects the results. Therefore a technique for welding the capsules with cooling was developed. Results of zirconium and titanium indicate that during irradiation an argon-oxygen atmosphere at 25°C the oxide-layer thickness increases. (E–t) curves at low currents in non-irradiation conditions for zirconium and titanate were investigated. It seems that the specimen preparation affects the results. In some cases proportionality was found between electric current and overpotential. The single-pulse technique was applied to out-of-pile work on Zircaloy-2. (auth)

14407 (HW-79766(p.5.1-16)) CHEMICAL METALLURGY. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Environmental Effects. Weight gains are reported for Zircaloy-2 coupons exposed to irradiation in G-7 loop water and exposed out-of-reactor to irradiated loop water. Results are reported for penetration tests in air and vacuum on Haynes alloy 25, Hastelloy X, and Inconel 600 at 1150 and 1200°C. Corrosion studies were made in flowing contaminated helium at 1200°C on Hastelloy X and Haynes 25 alloy welded to themselves and to each other. PRTR Materials Development. Weight gains and H_2 absorption rates in D_2O solutions of LiOD and H_2O solutions of LiOH at 275°C are reported for Zircaloy-2, Zircaloy-4, and crystal bar Zr. Studies were made of the corrosion of stressed AISI 304 stainless steel in pH 4.5 NaH_2PO_4 solutions at 275°C. Production Reactor Corrosion and Coating Studies. Pitting attack was initiated on rotated Al disks in 300 Area water, but an anodic polarization stopped the pitting and prevented the formation of the black film as well. Spectrographic analyses of Al corrosion product films are reported. A study was made of the heat transfer behavior of proposed in-reactor capsule designs. (D.L.C.)

14408 (ORNL-3541) EFFECT OF HEAT FLUX ON THE CORROSION OF ALUMINUM BY WATER. PART IV. TESTS RELATIVE TO THE ADVANCED TEST REACTOR AND CORRELATION WITH PREVIOUS RESULTS. J. C. Griess, H. C. Savage, and J. L. English (Oak Ridge National Lab., Tenn.). Feb. 1964. Contract W-7405-eng-26. 37p.

The corrosion of 6061 and X-8001 aluminum alloys and the resultant formation of an adherent corrosion product on the corroding surface were investigated under conditions (except radiation) comparable to those that will exist on the surface of fuel-element cladding during operation of the Advanced Test Reactor. Since previous experiments indicated that corrosion penetration of the aluminum clad was unlikely during a reactor cycle provided the water chemistry is properly controlled, most of the studies in this investigation were concerned with the effect of variables on the rate of formation of corrosion-product films. These films have low thermal conductivity and can be a major factor in producing high fuel-element temperatures which lead to fuel-plate instabilities. The experimental procedures were the same as used in a similar study for the High Flux Isotope Reactor, but the ranges of variables investigated were greater than in previous studies. The 6061 and X-8001 alloys corroded to the same extent under the same test conditions until the corrosion product (boehmite) that formed on the surface became thick enough to spall spontaneously from the surface, usually about 2 mils thick. Spallation from the surface of the 6061 alloy was always accompanied by localized attack of the underlying metal, whereas only uniform attack was observed with the X-8001 alloy under all conditions. Previously it was shown that the 1100 aluminum alloy behaved like the 6061 alloy in all respects. All three alloys developed corrosion-product coatings at the same rate when tested under the same conditions. The thermal conductivity of the corrosion product was determined to be 1.3 Btu hr^{-1} ft^{-1} $(°F)^{-1}$. The pH of the water was an important variable in determining the rate of corrosion-product buildup on aluminum. Under the same conditions the rate of oxide formation was 2.7 times greater when the pH of the water was 5.7 to 7.0 than when the pH was 5.0 (with nitric acid); pH was not a significant variable within the former range. Changes in pH during a test resulted in abrupt changes in the rate of oxide formation and presumably also in corrosion. The data indicated that up to the point of film spallation about 70% of the aluminum that was oxidized remained on the surface as boehmite regardless of test conditions; the rest was lost to the water. The rate of oxide formation on the specimens decreased with exposure time and increased as the surface temperature increased. The controlling temperature was that at the aluminum oxide–water interface (surface temperature). Considering only the data acquired with the water at a coolant pH of 5.0 and at heat fluxes between 1 and 2×10^6 Btu hr^{-1} ft^{-2}, the thickness of oxide built up on the corroding surface was described reasonably well by the empirical equation $X = 443\theta^{0.778} \exp(-4600/K)$, where X is corrosion-product thickness in mils, θ is time in hours, and K is surface temperature in degrees Kelvin. With pH values between 5.7 and 7.0, the same relation applied except that the first coefficient in the above equation was 1200 instead of 443. Within the range of 1 to 2×10^6 Btu hr^{-1} ft^{-2}, heat flux was unimportant except in the manner in which it influenced surface temperatures. Below 1×10^6 Btu hr^{-1} ft^{-2}, heat flux per se was a significant variable; considerably lower oxide thicknesses were observed than calculated by the above correlation. The results of the experimental program indicate that the 6061 aluminum alloy, which has mechanical strength superior to either 1100 or X-8001, will have adequate corrosion resistance for use as cladding for both the Advanced Test Reactor and the High Flux Isotope Reactor fuel plates, provided the pH of the water is maintained at 5.0 with nitric acid. However, the increase in fuel-plate temperatures resulting from the buildup of the corrosion-product layer must be evaluated carefully to determine its effect of the mechanical and irradiation behavior of individual fuel plates and on the overall fuel-element stability. (auth)

14409 (ORNL-3551) CORROSION OF REFRACTORY METALS BY LITHIUM. James Richard DiStefano (Oak Ridge National Lab., Tenn.). Mar. 1964. Contract W-7405-eng-26. 92p.

Thesis submitted to Univ. of Tennessee, Knoxville.

The pure metals niobium, tantalum, vanadium, titanium, and zirconium exhibit excellent resistance to dissolutive attack by lithium at temperatures even in excess of 800°C. However, the presence of small quantities of oxygen in either niobium or tantalum can cause the rapid penetration of these metals by lithium over a wide range of temperatures. Vanadium, titanium, and zirconium, on the other hand, do not show this susceptibility to lithium penetration even at oxygen concentrations in excess of 2000 parts per million. Penetration of niobium or tantalum by lithium results in the formation of a complex corrosion product in grain boundaries or along certain crystallographic planes. This reduces both the tensile strength and ductility of niobium. Oxygen was gettered from niobium, tantalum, and vanadium by lithium in all the tests. In the case of titanium and zirconium, oxygen redistribution occurred; but the direction, from solid metal to liquid metal or vice versa, depended on initial concentrations in the solid and liquid metal. At oxygen concentrations above 500 parts per million, temperature and grain size were the most significant variables affecting depth of penetration. Low temperatures and large grain size favored penetration along certain crystallographic planes while high temperature and small grain size favored grain-boundary attack. In tests with single crystals, penetration was observed to decrease with increased temperature. This was shown to be related to the rate at which oxygen diffused out of the niobium and was gettered by the lithium. Other variables such as time, heat treatment, prior deformation, and lithium purity were also investigated but were not found to be significant in the corrosion process. Possible solutions to this problem were afforded by the addition of alloying elements to niobium. It was shown that the addition of zirconium could be effective in eliminating lithium penetration. Alloys heat treated such that oxygen was tied up as the compound ZrO_2 did not corrode. Vanadium, on the other hand, was not effective in providing corrosion protection, presumably because it does not preferentially tie up oxygen present in the alloy. (auth)

14410 (ORNL-3558(p.104-12)) CORROSION STUDIES. J. L. English and J. C. Griess (Oak Ridge National Lab., Tenn.).

Since certain parts of the process equipment in the TRU Plant will contain mixtures of nitric and hydrochloric acids as well as the separate acids, a program to study corrosion rates on both Zircaloy-2 and Hastelloy C in these acid environments was carried out. The addition of enough nitric acid to 3M HCl to make the mixture 0.5M in HNO_3 had relatively little effect on the corrosion of either metal, but similar concentrations of nitric acid in 6M HCl drastically increased the corrosion rate of Hastelloy C (up to 100 mils/month at 43°C) and raised the rate on Zircaloy-2 at the boiling point from 0.2 to 1.6 mils/month. Zircaloy-2 has satisfactory corrosion resistance to all concentrations of nitric and hydrochloric acid at 43°C, but confirmatory tests showed that hydrogen pickup and embrittlement severely limited its use at boiling temperatures. Tests with Zirca-

loy-4 showed it in general to be less corrosion resistant than Zircaloy-2. Two tantalum-plated specimens remained in good condition after exposure to boiling 6M HCl for 1300 hr, although one developed a blister defect at the interface between two layers of tantalum plate. Hastelloy C corroded at less than 0.1 mil/month in all TRU organic media at 43°C. Homalite Cr-39, an allyl diglycol carbonate plastic used in the fabrication of the mixer-settlers for the Building 4507 development facility, was severely attacked in both 6M HCl and 8M HCl at 55°C, although it was quite stable in 10M LiCl–0.1M HCl. (auth)

14411 (EURAEC-928) RESEARCH ON CORROSION INFLUENCE OF A TENSILE STRESS. Special Report No. 11. J. Meunier (Brussels. Centre Belge d'Etude de la Corrosion). Dec. 1963. Work Performed under United States–Euratom Joint Research and Development Program. 13p. (A translation)

An investigation was conducted on the effects of a pull on the breakdown and protection voltages of polished wires of stainless steel types AISI 304, 316, and 410 in solutions containing 0.1 M $NaHCO_3$ and 10 or 60 g/l NaCl. The influence of the polishing method and chloride concentration on the voltages are discussed, and a comparison is made between the behavior of the steels. The effects of a twist on the voltages of 304 stainless steel were also studied briefly. (D.L.C.)

14412 (EURAEC-961) A STUDY OF SOME PROBLEMS OF METAL OXIDATION AND APPLICATION OF IMPEDANCE MEASUREMENT METHODS TO THE STUDY OF RESISTANCE TO CORROSION IN AN AQUEOUS MEDIUM. Quarterly Report No. 7, October 1–December 31, 1963. (Brussels. Universite). Work Performed under United States–Euratom Joint Research and Development Program. Contract 012-63-10TEEB. 15p. (A translation)

Results obtained by controlled oxidation of pure aluminum and selective oxidation of monocrystalline samples of Cu–Ni alloys are reported. In the case of aluminum, crystalline aluminum oxide seeds, γ–Al_2O_3, could be made to appear and develop. It was found for Cu–Ni alloys that a few hundred ppm of nickel are sufficient to modify copper behavior under oxidation. (auth)

14413 (FTD-TT-63-1020) STUDYING THE OXIDATION OF NIOBIUM-BASE ALLOYS. V. I. Grigorovich and A. I. Dedyurin. Translated from Tr. Inst. Met. im. A. A. Baikova, Akad. Nauk SSSR, No. 12, 214-40(1963). 37p.

An investigation was conducted on the alloying effects of Ti, V, Cr, and Mo additions to Nb–30% Zr alloys on the oxidation kinetics and oxygen penetration. The investigation was conducted in air at 500 and 1000° and various exposure times up to 20 hr. The results show that oxidation of Nb at 500° is reduced by 30% Zr and still further reduced by additional alloying with Ti, V, Cr, or Mo, while oxygen penetration is reduced by Zr but only slightly affected by Ti, V, Cr, or Mo. (D.L.C.)

14414 MICROGRAPHIC STUDY OF SLOW OXIDATION OF ZIRCONIUM. J. Perderau and J. Bardolle. Compt. Rend., 257: 2477-80(1963). (In French)

Development of the oxide layer at 800–850°C on Van Arkel and zone-melted zirconium in slow oxygen at low pressures was studied. An indicated mechanism comprising preferential oxygen diffusion and subsequent saturation (29 at.%) at the grain boundaries, followed by oxide growth involving the entire grains, is discussed. Oriented needle patterns due to growth perpendicular to the grain boundaries at 850°C are illustrated. (TCO)

14415 STRESS CORROSION OF TYPE 304 STAINLESS STEEL IN CHLORIDE ENVIRONMENTS. K. C. Thomas, H. M. Ferrari, and R. Allio (Westinghouse Electric Corp., Pittsburgh). Corrosion, 20: 89t-92t(Mar. 1964).

14416 OXIDATION OF BERYLLIUM IN CARBON DIOXIDE, UNDER PRESSURE AND AT HIGH TEMPERATURES. R. Darras, B. Dewanckel, and D. Leclercq. Energie Nucl., 5: 588-96(Dec. 1963). (In French)

Various qualities of sintered beryllium were exposed to carbon dioxide under pressure of 30 to 60 atm, from 600 to 700°C. By study of the kinetics of corrosion and by micrographic examinations, the unfavorable influence of the presence of small amounts of water vapor in the gas was determined. The presence of carbon monoxide in very small proportion (a few percent) in the carbon dioxide, did not notably modify the corrosion. On the other hand, between 60 and 30 atm, the lowering of the test pressure clearly improved the compatibility of one of the qualities of beryllium with CO_2 even in the presence of humidity. Lowering the concentration of water vapor in carbon dioxide to a few ppm is necessary in order that the use of commercial beryllium, in the presence of this gas, under high pressure, can be considered at temperatures equal to or above 600°C. (auth)

14417 CORROSION RESISTANCE OF STRUCTURAL STEELS IN LIQUID SODIUM. Georgi Ilincev (Akimov State Scientific Research Inst. for the Protection of Materials, Prague). Jaderna Energie, 10: 2-11(Jan. 1964). (In Czech.)

An experimental loop subjected to a temperature gradient and used for corrosion resistance investigations of materials in flowing sodium is described. A method of continual sodium purifying from oxides by means of metal filters and a method of oxygen determination in sodium are reported. The results of corrosion studies on various alloyed structural steels in liquid sodium with oxygen contents of 3×10^{-3} and 4 to 5×10^{-2}% are given. The tests took about 2000 hours at 550°C and at a flow rate 1.5 m/sec. The corrosion resistance of materials was determined by changes in weight and mechanical properties, and metallographically. The results may be used for the design of sodium-cooled heat transfer equipment. The corrosion of all steels was rather low (up to 120 mg/dm^2/month). At higher oxygen contents the weight decrease of most steels investigated was 5 to 7 times more and the corrosion depth 2 to 3 times larger. The corrosion resistance increased with the increase of chromium content in steel. Steels containing under 17% chromium were decarbonized with sodium. Steels containing under 2% chromium, in which the carbon was bound in the cementite-type carbides, underwent both decarbonization and intercrystalline corrosion. Corrosion attack of low-carbon ferritic steels stabilized with Ti or Nb was substantially lower than that of non-stabilized steels. Stabilized steels were not decarbonized by sodium. Heat transfer was considerably accelerated by the increase of oxygen content. Sodium with oxygen contents not exceeding solubility did not evoke intercrystalline corrosion of anticorrosive steels. The change of mechanical properties of 18Cr8Ni-type anticorrosive steels caused by corrosion in the presence of oxygen up to 4 to 5×10^{-2}% was relatively small and did not exceed 10% of their values after thermal aging at uniform temperature. (auth)

14418 ON CORROSION TESTING OF ZIRCONIUM–NIOBIUM ALLOYS. R. Rauschenbach and H. Spindler (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 7: 19-22(Jan. 1964). (In German)

Comparative studies were made of the corrosion behavior of Nb–Zr alloys with 0.5, 1, and 2 wt % Nb in water vapor at 400°C and 120 and 1 "kp cm^{-2}," which had as their goal replacing the usual acceptance testing of this material in high-pressure vapor with the less used testing under normal pressure. It is shown that in the pressureless investigation higher mass increases were obtained, but independent of alloy content and of the testing time, good parallels between both test conditions existed. Data on allowable mass increases are given. (tr-auth)

14419 CORROSION OF HIGH-TEMPERATURE MATERIALS IN ALKALI METALS. Kenneth J. Kelly (United Aircraft Corp., Middletown, Conn.), Carl J. Klamut, Louis Rosenblum, J. W. Semmel, Jr., and William C. Thurber. Nucleonics, 22: No. 3, 37-42 (Mar. 1964).

The development and testing of a niobium alloy-contained lithium primary system and potassium secondary system for space reactor application are reviewed. (R.E.U.)

14420 SOME OBSERVATIONS OF SHORT TIME CORROSION OF REFRACTORY METALS IN LITHIUM BETWEEN 2000 AND 3000°F. H. Hahn and M. Jaworsky (Curtiss-Wright Corp., Wood-Ridge, N. J.). 15p. (CONF-373-6)

From Technical Conference on Applied Aspects of Refractory Metals, Los Angeles, Dec. 1963.

Investigations on the short time corrosion in lithium between 2000 and 3000°F were carried out on Nb, Cr, Mo, Ta, W, Nb–Ta–Zr, and Ta–W. Exposure times of one and, in some instances, of four minutes, were utilized. Lithium corrosion resistance is reported in terms of scaling, weight change, and subsurface attack. Of all materials tested, Ta was found to possess the lowest resistance to lithium attack. The results are discussed and data are tabulated. (P.C.H.)

Fabrication

14421 (CONF-373-4) THE DEVELOPMENT OF REFRACTORY-METAL BRAZING ALLOYS FOR ELEVATED-TEMPERATURE SERVICE. R. G. Gilliland (Oak Ridge National Lab., Tenn.). [1967]. Contract [W-7405-eng-26]. 13p.

From Technical Conference on Applied Aspects of Refractory Metals, Los Angeles, Dec. 1963.

In order to advance the existing technology of refractory-metal fabrication, a development program is under way to produce brazing alloys for joining the refractory materials for service up to 3500°F. The program has been conducted in two phases: the development of brazing alloys for service (1) to 1700°F and (2) to 3500°F. The first phase of the brazing alloy development program started with the formulation and testing of a large number of zirconium- and titanium-base ternary alloys. After preliminary studies concerned with the alloy wettability and flowability on refractory metals, the most promising alloys were evaluated through thermal cycling and aging tests and mechanical shear strength determinations. The results indicated that the alloy compositions, 48Zr–48Ti–4Be and 75Zr–19Cb–6Be (wt %), are particularly promising for a wide variety of joining operations on refractory materials at service temperatures up to 1700°F. The second phase of the alloy development program is currently in the preliminary stages. Initial investigations indicate that the ternary alloy systems of Cb–Ta–V and Ti–Ta–V appear very promising for service in the higher temperature range. Current results reveal that alloys from these systems, which melt in the range of 3000 to 3700°F, exhibit excellent wettability and flowability on the refractory materials and produce extremely ductile joints at room temperature. Additional testing will be performed to determine the properties of joints brazed with these and other alloys at temperatures up to 3500°F. (auth)

14422 (CONF-373-8) TECHNIQUES FOR EXTRUSION OF SMALL-DIAMETER REFRACTORY METAL TUBE BLANKS. W. R. Burt, Jr., and R. M. Mayfield (Argonne National Lab., Ill.). [1963]. Contract W-31-109-eng-38. 11p.

From Technical Conference on Applied Aspects of Refractory Metals, Los Angeles, Dec. 1963.

An alternate approach to mandrel extrusion was investigated for extruding a tube with an ID of ½ in. or smaller. A co-extrusion technique that incorporates an internal core in the billet that reduces proportionately with the refractory metal sleeve is discussed. The advantages and disadvantages of mandrel-less extrusion techniques and relation of mandrel-less extrusion techniques to secondary fabrication operations are discussed. It was concluded that use of a co-extrusion technique with a deformable core material eliminates the use of a mandrel, ID contamination and lubrication, and results in a smaller diameter extruded tube. (P.C.H.)

14423 (CONF-373-9) EVALUATION OF NEW FABRICATION TECHNIQUES FOR HIGH-QUALITY REFRACTORY METAL TUBING. J. E. Flinn and R. M. Mayfield (Argonne National Lab., Ill.). [1963]. Contract W-31-109-eng-38. 11p.

From Technical Conference on Applied Aspects of Refractory Metals, Los Angeles, Dec. 1963.

Methods for the fabrication of small diameter thin-wall tubes are described and evaluated. The fabrication of V, Cu, Nb, Ta, and Ta–W tubes is discussed. (P.C.H.)

14424 (HW-79522) REMOTE WELDING CLOSURE FOR RADIOACTIVE WASTE STORAGE CONTAINERS. Final Report. V. L. Hammond (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 13, 1963. Contract AT(45-1)-1350. 26p.

Studies were conducted on welding techniques for remote closure of high-level radioactive waste storage containers. The effects of welding variables were studied. The tungsten inert gas welding process was found to be satisfactory for producing high-integrity closures on stainless steel containers. (D.L.C.)

14425 (NAA-SR-Memo-9299) FEASIBILITY REPORT FOR FABRICATION OF SNAP FUEL ELEMENTS. T. S. Kirsch (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 11, 1963. Contract [AT(11-1)-Gen-8]. 57p.

The general requirements for the SNAP Reactor Cores include the fabrication of fuel elements. These elements consist nominally of 90 wt % zirconium-10 wt % highly enriched uranium (93% U^{235}) rods hydrided to an N_H of 6.0–6.5 and machined. Alloying will be accomplished by triple arc melting. Forming will be done by extrusion, massive hydriding by techniques developed at Atomics International, and cladding by conventional means. (auth)

14426 (ORNL-3558(p.61-83)) DEVELOPMENT OF A FABRICATION PROCESS FOR HFIR TARGET ELEMENTS. D. A. Douglas (Oak Ridge National Lab., Tenn.).

The problem of achieving cermet pellets of the desired density and acceptable thermal conductivity was solved.

About 200 good pellets were produced for the prototype target rods. The design of the joint for welding the end closures was modified, and procedures were developed by which good welds can be made in glove box operations, but the problem of consistently achieving a high-quality weld by remote operation was not completely solved. Six prototype target rods containing PuO_2 were made in a glove-box line, and four of these are being irradiated in the Materials Testing Reactor. Conceptual design, construction, and operational checking of the equipment for the three cubicles in the TRU facility are proceeding on schedule. (auth)

14427 (ORNL-TM-767) FABRICATION AND CHARACTERIZATION OF HIGH-PURITY BERYLLIUM OXIDE SPECIMENS FOR IRRADIATION TESTING. R. L. Hamner (Oak Ridge National Lab., Tenn.). Mar. 1964. Contract W-7405-eng-26. 23p.

Approximately 900 high-purity beryllium oxide specimens were fabricated for irradiation testing. The specimens were of two sizes and of four types: high-density specimens (96 to 98% of theoretical) in two grain sizes (average grain diameters were 24 and 70 μ) and low-density specimens (89 to 90% of theoretical) also in two grain sizes (17 and 34 μ). Cold pressing and sintering were used to fabricate the specimens to dimensional tolerances of ± 0.002 in. without machining. Fabrication procedures were based on studies of the effect of green density and sintering time on the shrinkage and sintered densities of the specimens. The high-density specimens were prepared without the use of binders. The low-density specimens were sintered under the same conditions, but an epoxy resin was used as a fugitive organic material to provide high porosity. Small-grain specimens were sintered for 1 hr and large-grain specimens for 60 hr, both in hydrogen at 1750°C. The specimens were characterized by chemical analysis, photography, radiography, surface examination, and measurement of densities, pore spectra, and dimensions. (auth)

14428 (RD-63-105) THE FABRICATION OF BERYLLIUM POWDER FORGING. N. G. Orrell (Wyman-Gordon Co., Worcester, Mass.). [1963]. 85p.

A thorough description is given of the actual manufacturing details of the beryllium powder forging process and the component capability. The design criteria and limitations of the process are discussed. The mechanical properties of forged beryllium powder are described in detail. (D.L.C.)

14429 (TID-3577) FLUXES AND THEIR USE IN SOLDERING ALUMINUM. A Literature Search. James M. Jacobs, comp. (Division of Technical Information Extension, AEC). Feb. 1964. 24p.

A total of 452 references to the report and published literature is cited. Report Number, Author, and Patent Indexes are included. (auth)

14430 (TID-7676(p.10-24)) PROCESS DEVELOPMENT ON THE FABRICATION OF URANIUM CARBIDE FUEL ELEMENTS AT ATOMICS INTERNATIONAL. D. K. Magnus, H. Pearlman, and M. H. Binstock (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

An intensive process development program is being conducted on the fabrication of uranium carbide fuel elements for use in large sodium-graphite reactors. During this time, over 7500 kg of depleted and enriched uranium carbides were processed as melt stock, slugs, and fuel elements. The objective of the program is the development and demonstration of low-cost processes which will permit the fabrication of full scale fuel elements at prices that are competitive and economically attractive. The fabrication cost goal is stated as "not greater than $100/kg of contained uranium in the finished element." A review of the problems that were encountered throughout the various process steps, a description of the fuel element, and a summary of the progress to date are presented. (auth)

14431 (TID-7676(p.68-9)) CARBIDE DEVELOPMENT FOR THE SETTLED-BED REACTOR. G. Pancer and R. Powers (Brookhaven National Lab., Upton, N. Y.).

Fuel in the form of $\frac{1}{8}$ in. dia spheres of UC for the settled-bed fast-breeder reactor is being developed and tested. Material fabricated by arc melting appeared to have better properties than that fabricated by powder metallurgy. (M.C.G.)

14432 (TID-7676(p.70-4)) CARBIDE FUEL DEVELOPMENT AT THE CARBORUNDUM COMPANY, RESEARCH AND DEVELOPMENT DIVISION, NIAGARA FALLS, NEW YORK. K. M. Taylor, C. H. McMurtry, and J. C. Andersen (Carborundum Co. Research and Development Div., Niagara Falls, N. Y.).

Pellets of UC containing certain added impurities (UO_2, UC_2, UN, and U) were prepared for irradiation testing. Small amounts of nickel were used as a sintering aid. The addition of 0.1 to 0.2% nickel made it possible to readily obtain densities 95% of theoretical and at the same time to lower the normal sintering temperature 300 to 400°C. In sintering PuC–UC fuels in helium using 0.1% nickel, densities of about 95% theoretical were obtained readily at 1500 to 1550°C. (M.C.G.)

14433 (TID-7676(p.135-44)) PREPARATION OF URANIUM CARBIDE AND FABRICATION OF CAST RODS BY CENTRIFUGAL CASTING AND TILT POURING. P. Himmelstein, B. Liebmann, and H. Schaefer (Nuklear-Chemie und-Metallurgie G.m.b.H., Wolfgang bei Hanau am Main, Germany).

Methods for the production of UC melting stock and for the fabrication of cast uranium carbide rods were developed. The melting stock was prepared by solid-state reaction of uranium dioxide and carbon; the rods were produced by skull melting and centrifugal casting. All the steps required for a UC pilot plant were studied. A comparison between the fabrication lines for UO_2 pellets and cast UC rods showed that the price of UC rods could come close to that of UO_2 pellets if real production was started and continued for several years. (auth)

14434 (TID-7676(p.145-53)) URANIUM MONOCARBIDE FABRICATION WITH UAl_2 AS SINTERING AID. Joseph P. Hammond, J. D. Sease, and C. Hamby, Jr. (Oak Ridge National Lab., Tenn.).

Of various metals and intermetallics examined for lowering the fabrication temperature of UC, UAl_2 in amounts of between 5 and 10 wt % gave the best results. By sintering in a vacuum of 10^{-6} to 10^{-7} torr at only 1350 to 1400°C, UC structures virtually free of any secondary constituents were achieved and with densities consistently in excess of 97% of theoretical. (M.C.G.)

14435 (EURAEC-907) STUDY OF ELEMENTARY CRACKING WELDING PROCEDURE. PRELIMINARY PROTOTYPE STUDY. Quarterly Report No. 4, October 1–December 31, 1963. (Institut de Soudure, Paris). Jan. 16, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 090-12-RDF. 14p. (A translation)

Using Y sections (parallel to the rolling direction), YX beads were deposited (perpendicular to the plate skin) by arc welding using a rutile electrode and by automatic flux welding. The hardnesses under welding deposits were

investigated by Vickers hardness tests and preliminary results are discussed. A systematic study of the presence and arrangement of under-bead cracks was made. The Pellini tests were completed. (N.W.R.)

14436 (EURAEC-908) FABRICATION OF FUEL UNITS CONSISTING OF A DISPERSION OF PuO_2 IN A MATRIX OF MgO OR Al_2O_3. Special Report No. 16. K. Richter (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Fontenay-aux-Roses). Aug. 1963. Work Performed under United States–Euratom Joint Research and Development Program. 34p. (A translation)

Theoretical considerations led to adding 10% PuO_2 by weight under two forms: with grains of less than 35 μ or grains between 35 μ and 135 μ, as pellets of the second type should behave better under irradiation. Eighty MgO–PuO_2 pellets with a density of 95% were fabricated for irradiation experiments by calcination of Mg CO_3 at 980°C, pelletization, and then sintering at 1700°C in hydrogen. For the same reason, seventy Al_2O_3–PuO_2 pellets were prepared by precipitation of aluminum hydroxide, calcination at 1000°C, pelletization, and then sintering at 1700°C in hydrogen. The two methods are reproducible and simple to execute. The proposed experiments on extrusion were not carried out. For the same reasons, the Al_2O_3–PuO_2 pellets were not re-fabricated, although the density obtained was lower than expected (82–90%). (auth)

14437 HOT-PRESSING MIXED CARBIDES OF Ta, Hf, AND Zr. John J. Fischer (Lewis Research Center, Cleveland). Am. Ceram. Soc. Bull., 43: 183-5(Mar. 1964).

The effect of hot-pressing parameters (temperature, pressure, and time) on the density and grain size of two mixed carbides, 80% TaC 20% HfC and 80% TaC 20% ZrC (at. %), was investigated. The purpose of the investigation was to determine what conditions would be necessary to produce high-density bodies and what resultant grain size might be expected for a given set of conditions. The hot-pressing was accomplished by means of an inductively heated graphite die body with pressure being supplied by a hydraulic press. Based on the computed theoretical densities, 4TaC · 1HfC was hot-pressed to approximately 100% relative density at 4600°F and 6000 psi in 15 minutes. The maximum density achieved in the 4TaC · 1ZrC composition was 96% relative density under the same conditions. Based on grain size measurements there is evidence of a recrystallization temperature for both materials at about 4600°F under a hot-pressing pressure of 3700 psi. (auth)

14438 PROCEDURES AND APPARATUS FOR WELDING NUCLEAR REACTOR INSTRUMENT TUBING. A. C. Stewart and C. M. Bishop. Can. Welder Fabricator, 54: No. 10, 21-3; 26; 28; 30(Oct. 1963).

Techniques and equipment for TIG welding successive lengths of 304L stainless steel, A179 plain carbon steel, and Cu-Ni tubing for use in nuclear reactors are described. The effects of oxidation on the mechanical strength were determined and the results of radiographic and metallographic examination are given. Included is a table of typical weld cycle conditions for producing high quality welds. (Rev. Metal Lit., 2: No. 1, Jan. 1964)

14439 ELECTROFORMING REFRACTORY METALS. Iron Age, 192: 158-9(Oct. 10, 1963).

Development of a new process for electrocladding and electroforming refractory metals (W, Ta, Mo, Nb, Hf, V, Zr, Cr) is described. The process produces an impervious metallic deposit of ultra pure refractory metal. Mechanical properties given for electroclad and electroformed deposits are melting point, density, thermal conductivity, and thermal expansion. (Rev. Metal Lit., 21: No. 1, Jan. 1964)

14440 PROTECTIVE COATINGS FOR TUNGSTEN. C. D. Dickinson, M. G. Nicholas, A. L. Pranatis, and C. I. Whitman. J. Metals, 15: 787-92(Oct. 1963).

Analysis was made of the reactions with the environment, vaporization processes, and coating-substrate reactions important in high-temperature oxidation-resistant coatings for tungsten. Evaluation of Pt-group metal and silicide coatings were given. (Rev. Metal Lit., 21: No. 1, Jan. 1964).

14441 SOME ASPECTS OF SINTERING BEHAVIOR OF PULVERIZED PREPARATION OF URANIUM DIOXIDE. Ludmila Jakešová and Milan Podéšt (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jaderná Energie, 9: 373-8(Dec. 1963). (In Czech)

The sinterability of some preparations of UO_2 powder differing by the "degree of crystallite agglomeration," i.e., by the ratio of particle size calculated from the specific surface area value to the particle size determined by the x-ray diffraction method, was investigated. This ratio was designated as "ϑ-coefficient." At 1600°C, all preparations investigated showed a maximum on the curve of the after-sintering density to green density relationship. The lower the ϑ-coefficient, the higher the maximum density values after sintering were. For reaching maximum density after sintering the material may be pressed to 48 to 52% of the theoretical density. On the basis of theoretical results, it was found that the UO_2 preparation with ϑ-coefficient equal to 7.53 differed considerably from other preparations, and an assumption was made that the agglomerates of this powder were so compact that they acted as individual crystallites. (auth)

14442 MICROGRAPHIC OBSERVATIONS ON SINTERED URANIUM OXIDE. A. Bassi (CISE, Segrate, Italy), G. Camona, G. Dassù, and G. Piazzesi. Met. Ital., 55: 569-79 (Nov. 1963). (In Italian)

Since the study of sintering of UO_2 is essentially the observation of the porosity present in the material and its evolution during various treatments, a technique for the electron micrographic study of the fracture surface was developed. This technique is shown to give rigorous and reproducible information on the state of the material. The results obtained and the conclusions derived are reported. Micrographs of grain growth, attack figures, and flaking figures are reproduced in illustration. (tr-auth)

14443 EXTRUDING REFRACTORY METALS. I. Perlmutter and Vincent DePierre. Metal Progr., 84: No. 5, 90-5; 128; 130; 132; 134; 136(Nov. 1963).

The effects of die coatings, billet shapes, lubricants, extrusion ratios and temperatures, chemical compositions, and other factors on the extrusion of Mo, Nb, Ta, W, and their alloys are discussed. (TCO)

14444 FABRICATING AND COATING MOLYBDENUM ALLOY PARTS. Gary Michaelson (Boeing Co., New Orleans). Metal Progr., 85: 88-91(Mar. 1964).

Three methods developed to resolve manufacturing problems and to reduce the cost of fabricating molybdenum alloy hardware for space age vehicles are discussed. The methods are: chemical blanking, vibratory radiusing, and coating in a fluidized bed. (P.C.H.)

14445 ON THE FEASIBILITY OF Nb_3Sn SUPERCONDUCTIVE SOLENOIDS. L. Gold (Kennecott Copper Corp., Lexington, Ky.). Phys. Status Solidi, 4: 5-8(1964).

Methods for fabrication of Nb_3Sn superconductive solenoids are discussed. Problems included embrittlement by

hydrogen and abnormal grain growth. Suggestions for solving these problems are offered. Finely divided Al_2O_3 is recommended to inhibit abnormal grain growth. By using organic stannates in which the free hydrogens are replaced by appropriate organic radicals, hydrogen attack is expected to be reduced. (M.C.G.)

14446 SPECIAL FABRICATION TECHNIQUES. (Battelle Memorial Inst., Columbus, Ohio). Reactor Mater., 6: No. 4, 70-9(Winter 1963-64).

Development progress on the following fabrication techniques is discussed: melting, hot and cold working, cladding by rolling and swaging, pressure bonding, diffusion bonding, extrusion cladding, canning, electroplating, nonelectrolyte chemical plating techniques, welding, and brazing. (62 references). (M.C.G.)

14447 FABRICATING NUCLEAR REACTORS: WELDING MEETS THE CHALLENGE. Henry Lefer. Welding Design Fabric., 36: No. 10, 51-4(Oct. 1963).

TIG and electron beam welding of Zircaloy 2, Nb, and 304L stainless for the fabrication of nuclear reactor components such as nuclear fuel reclaimers, control rod guide assemblies, tubular control rods, convoluted Zircaloy tubes, and finned superheat tubing are discussed. (Rev. Metal Lit., 21: No. 2, Feb. 1964)

14448 WELDING EVALUATION OF EXPERIMENTAL COLUMBIUM ALLOYS. G. G. Lessmann (Westinghouse Electric Corp., Pittsburgh). Welding J. (N.Y.), 43: 103s-15s(Mar. 1964).

Welding studies conducted concurrently with an alloy scale-up effort in which several promising Nb alloy systems were evaluated are described. Emphasis on alloy evaluation was placed on weldability as well as strength. In particular, alloy ductility as determined by bend testing in both the base metal and weld metal was stressed. Nb is strengthened significantly by alloying with the elements Mo, W, V, and/or Zr. The alloying systems investigated included Nb–V, Nb–Mo–V, Nb–Mo–V–Zr, and Nb–W–V–Zr. Both high and low interstitial alloys were investigated. Good as-welded ductility was obtained only in those having low total interstitial levels (<300 ppm total C, O, and N). The Nb–5Mo–5V–1Zr alloy proved to be most promising providing high tensile strength (38000 psi at 2200°F) with a minimum compromise of weldability and weld ductility. (P.C.H.)

14449 FUSION WELDING OF BERYLLIUM. E. M. Passmore (Avco Corp., Wilmington, Mass.). Welding J. (N.Y.), 43: 116s-25s(Mar. 1964).

Joining of beryllium (Be) plates by gas tungsten-arc braze welding and fusion welding with a-c current was investigated with the objectives of: evaluating the techniques for applications at temperatures up to 1300°F; and elucidating some of the factors affecting weld quality. Oxidation during welding was effectively controlled by means of an argon atmosphere inside a vacuum-tight dry box. Braze welds were made using filler strips of an aluminum-12 silicon (Al–12Si) alloy and of unalloyed silver (Ag), arc melted in place. Using either filler metal, room temperature tensile strengths in the direction transverse to the weld were found to be in the range 20 000 to 25 000 psi under optimum conditions. Although Al–12Si braze welds do not appear to be useful for elevated temperature applications, transverse tensile strengths of Ag braze welds amounting to about 11 000 psi at 1300°F, which is more than 80% of the base metal strength at this temperature, indicate a potential usefulness for such applications. The tendency toward tearing and cracking during fusion welding was found to be reduced by increasing preheat temperature and by decreasing speed and current, as long as comparisons are made between fusion zones of similar size and geometry. The tendency toward tearing and cracking also decreased with decreasing fusion zone size, as measured by penetration. However, with current maintained constant at 150 amp, the effect of increasing speed counteracted the associated decreasing penetration, so that no change in tearing occurred. Additions of aluminum (Al) to the fusion zones in amounts of about 1% or less were found to promote tearing. Variations in the susceptibility to tearing encountered in the various lots of Be tested were attributed to variations in the Al content. (auth)

14450 A METHOD OF ALLOYING R18-TYPE DEPOSITS WITH CARBON AND TUNGSTEN. V. M. Panovko. Welding Prod. (USSR) (English Transl.), No. 2, 16-21(Feb. 1963).

The effects of the method used for introducing carbon and tungsten (combined as WC or W_2C or separately in the form of ferro-tungsten and graphite) into deposits of high speed steel on the structure and mechanical properties of the deposit were studied. The red hardness and microstructure of the deposit after quenching is presented graphically. (Rev. Metal Lit., 21: No. 1, Jan. 1964)

14451 INDUCTION COUPLED PLASMA TORCH. Paul D. Scholz, Morris E. Brodwin, and Thomas P. Anderson (Northwestern Univ., Evanston, Ill.). 8p. (CONF-414-7)

From Conference on Direct Energy Conversion, Argonne, Ill., Nov. 1963.

The development of a radiofrequency induction coupled plasma torch is described. A variable frequency, 5-22 Mc, 5 kw vacuum tube oscillator was used. Gas is introduced to the generator at one end of a one-inch pyrex tube with a swirling motion so as to provide cooling for the walls. The vortex flow then passes through the induction coil where it is ionized. Flow tracer studies of the flow characteristics in the tube showed that there is considerable tangential flow in the region of the induction coil. (P.C.H.)

14452 IMPROVEMENTS IN OR RELATING TO MAGNESIUM BASE ALLOYS. James Henry Thomas Petch and Philip Andrew Fisher (to Magnesium Elektron Ltd.). British Patent 950,628. Feb. 26, 1964. Filed Apr. 29, 1960.

A method is described for producing a casting in a magnesium-base alloy containing 0.1 to 1.0 wt % Zr. The alloy is puddled at up to 700°C in the presence of a three-phase zirconium-zinc alloy that is capable of introducing zirconium into the magnesium. (R.E.U.)

Properties and Structure

14453 (AERE-M-1251) EXPERIMENTS RELATING TO THE MECHANISM OF THE DIFFUSION OF XENON-133 IN URANIUM DIOXIDE. G. Long, W. P. Stanaway, and D. Davies (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1964. 12p.

The emission of xenon-133 from samples of uranium dioxide/yttrium oxide and thorium oxide/yttrium oxide solid solutions containing up to 30 mole % of yttrium oxide was investigated by heating in the range 800 to 1600°C after a short irradiation. It is concluded that the migration of xenon-133 in these systems does not rely on the presence of vacancies on the oxygen sub-lattice. The results of a series of experiments on the emission of xenon-133 from a

stressed sample of uranium dioxide suggest that dislocations in the lattice also play no part in the migration of xenon-133. (auth)

14454 (BM-RI-6390) COLUMBIUM AND TANTALUM ALLOYS SUITABLE FOR USE AT HIGH TEMPERATURES. H. R. Babitzke, M. D. Carver, and H. Kato (Bureau of Mines. Albany Metallurgy Research Center, Ore.). Oct. 1962. 28p.

A number of columbium and tantalum alloys were investigated to determine their suitability for use at elevated temperatures. Columbium–vanadium, tantalum–vanadium, and tantalum–hafnium alloys, and also columbium–10 wt % titanium alloys modified with additions of 0.1 to 2 mole % ZrO_2, TiO_2, ZrB_2, TiB_2, ZrC, or TiC were prepared and examined. Workability, tensile properties, and oxidation resistance were tested. Of the columbium alloys studied, the columbium-12 at. % vanadium exhibited the best properties; it compared closely with the columbium–10 at. % vanadium alloy studied in a previous investigation. (auth)

14455 (CNLM-4094) ALKALI METAL PHYSICAL PROPERTIES PROGRAM AT PRATT & WHITNEY AIRCRAFT-CANEL. S. M. Kapelner and R. E. Cleary (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). [1961]. Contract AT(30-1)-2789. 21p. (CONF-406-1)

From 2nd Annual High Temperature Liquid Metal Heat Transfer Technology Meeting, Upton, N. Y., May 1962.

A method was developed for measuring the electric resistivity of alkali metal at high temperatures, and measurements are reported for Li up to 865°C, Na to 853°C, K to 764°C, Rb to 752°C, and NaK-46 to 855°C. Thermal conductivities of the alkali metals were calculated from the electric resistivities. The solubility of helium in Li was studied as a function of temperature and pressure between 650 and 870°C. Equipment is described for measuring the viscosities, wetting characteristics, vapor pressure, and vapor density of the alkali metals. (D.L.C.)

14456 (CONF-373-10) THE EFFECT OF DEGREE OF VACUUM ON THE SLOW-BEND CREEP BEHAVIOR OF COLUMBIUM-0.6% ZIRCONIUM AT 1000°C. T. K. Roche (Oak Ridge National Lab., Tenn.). [1963]. Contract W-7405-eng-26. 20p.

From Technical Conference on Applied Aspects of Refractory Metals, Los Angeles, Dec. 1963.

Nb and its alloys are subject to interstitial contamination in vacuum environments and the interstitials, in turn, influence the mechanical properties of these materials. To investigate creep behavior during contamination, the deflection rates of cantilevered Nb–0.6% Zr specimens, loaded to an initial outer fiber stress of 12,500 psi, were determined at pressures ranging from approximately 10^{-7} to 10^{-5} torr for a test period of 504 hr at 1000°C. A typical deflection-time curve exhibited an approximately linear "steady-state" deflection rate during the early stages of test followed by a continuously decreasing rate for the duration of the test. It was observed that systematic increases of the test pressure progressively weakened the alloy during the "steady-state" stages and strengthened the alloy during the latter test stages. At a test pressure in the range of 1.6 to 6×10^{-5} torr, the alloy was significantly weakened at a still later stage of testing. To further demonstrate the effect of the test pressure, it was possible to accelerate or decelerate the deflection rate of a single specimen by increasing or decreasing the test pressure. The observed slow-bend creep behavior was correlated with the contamination experienced by the alloy from the residual gases in the vacuum system. This correlation was supported by posttest chemical analyses for interstitials and metallographic observations. It was concluded that the test pressure is an important variable influencing the slow-bend creep behavior of Nb–0.6% Zr. (auth)

14457 (DRI-2141) RESEARCH ON THE SAMARIUM-TYPE INTERMEDIATE PHASES OF INTRA-RARE-EARTH BINARY SYSTEMS. Technical Report No. 2. Charles E. Lundin and J. F. Nachman (Denver. Univ. Denver Research Inst.). Jan. 1964. Contract Nonr-3661(02). 33p.

Five binary intra-rare-earth systems were investigated to confirm the existence of the samarium-type intermediate phase. These systems are: La–Ho, Ce–Gd, Ce–Ho, Nd–Gd, and Nd–Ho. The systems were studied primarily by metallography and x-ray-diffraction techniques. The limits of the single-phase terminal solid solutions and the two-phase regions were determined. Lattice parameters for the intermediate phases were determined, and the approximate composition of each was established. A complete metallographic analysis of the phase equilibria in each system is presented. The position of the intermediate phase correlated well with a size effect factor of the two components in each respective system. (auth)

14458 (EIR-49) SELBSTDIFFUSIONSVERSUCHE IN α-ZIRKON. (Self-diffusion in α-Zirconium). Peter Flubacher (Switzerland. Eidgenössisches Institut für Reaktorforschung, Würenlingen). May 1963. 21p.

Measurements of the self-diffusion coefficient were made between 751 and 845°C on three materials different in purity and preliminary treatment. Zr^{95} was used as tracer, and, in spite of the small diffusion coefficients of 10^{-12} to 10^{-13} cm^2/sec, the classical "slicing technique" was applied. Before counting, the daughter product Nb^{95} was chemically separated. The penetration curves showed at great penetration depths a tail, which cannot be traced back to volume diffusion. The results of the three materials do not vary significantly from each other within the relatively large scattering. An analysis by the least-squares method gave for the diffusion coefficient $D_{Zr} = 5.6 \times 10^{-4} \exp(-45500/RT)$ cm^2/sec. The activation energy of 45500 cal/mole was small but corresponded qualitatively with other properties as resistance and annealing mechanism of radiation damage. (tr-auth)

14459 (EUR-550.f) CONTRIBUTION A L'ETUDE DE LA PLASTICITE DU SAP. (Study of the Plastic Deformation Mechanisms of SAP). P. Guyot (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 27p. (CONF-167-4)

From Journees Metallurgiques d'Automne, Paris, Oct. 1962.

Fundamental plastic deformation mechanisms in the composite material aluminum-alumina were studied. The activation energy and activation volume were determined from room temperature to 600°C. On the basis of the results obtained, different hypothesis are proposed: the dislocations move by cross-slip and climb until 300–350°C; for the higher temperatures, a pinning-unpinning process of dislocations by the alumina particles is starting; a theoretical model is advanced. (auth)

14460 (EUR-584.f) BLOCAGE DES DISLOCATIONS DANS LES ALLIAGES DU TYPE SAP/Al–Al_2O_3. (Blocking of Dislocations in the Al/Al_2O_3 Alloys). P. Guyot (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 14p.

The blocking of dislocations by alumina particles in the Al/Al_2O_3 alloy was studied. A model is proposed to cal-

culate the activation energy of the unblocking process, under the influence of thermal agitation and applied stress. For low temperatures, the deformation probably proceeds by cross-slip and climb of dislocations in aluminum matrix. (auth)

14461 (EUR-589.f) EVOLUTION STRUCTURALE DE L'ALUMINE DANS LE S.A.P. FONDU. (Structural Changes in Alumina in Molten SAP). G. Beghi, G. Piatti, and D. Quataert (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 42p. (CONF-425-1)

From Conference on Nonfissile Metals for Nuclear Reactors, Bologna, Dec. 1963.

A study was carried out on SAP in the temperature range above a melting point of aluminum with a view to assessing the limits for the appearance of the typical dispersed-phase structure of the SAP itself and in order to gain some indications from the structural standpoint. Various heat treatments were effected. A partial transformation was observed in the alumina from the finely-dispersed initial γ structure into an α structure of relatively larger crystals at a growth rate proportional to temperature. The γ-alumina/α-alumina transformation, which normally occurs at temperatures of the order of 1000°C, takes place in SAP at just above 660°C. The phenomenon was observed, in the samples treated, by microscopic inspection (optical and electron) and by radiocrystallographic examination. The trend followed by this phenomenon in relation to temperature and time was determined, and it proved possible to calculate the activation energy of this $\gamma \rightarrow \alpha$ transformation (61 kcal/mole). (auth)

14462 (EURAEC-851) IMPERFECTIONS IN METALS. II. CORROSION AND OXIDATION. Quarterly Report No. 4, July 1–September 30, 1963. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). Work Performed under United States–Euratom Joint Research and Development Program. Contract 082-62-7-RDB. 19p. (R-2249)

Fringe patterns typical for stacking fault contrast were observed in annealed niobium. The features were found to extend the specimen border, to inhibit the motion of the dislocations, and to show sometimes a morphology not concordant with the stacking fault hypothesis. Small ones were seen in the neighborhood of grain boundaries. The habit plane was determined to be of the {310} family whereas the border inside the foils has mostly the [100] direction. In no cases motion of the fringe systems was observed. The observed fringe patterns must be attributed to very thin plate-shaped precipitates of a few monolayers thickness. The possibility is put forward that the observed phenomenon could be a mechanism of internal oxidation. The inhibited motion of the dislocations can explain physical properties of gas contaminated niobium. (auth)

14463 (EURAEC-932) THE EFFECT OF RADIATION ON THE DUCTILE-BRITTLE TRANSITION IN PRESSURE VESSEL STEELS. Special Report No. 2 ON THE POSSIBLE RELATIONSHIP BETWEEN TWINNING AND BRITTLE FRACTURE IN IRON AND OTHER BODY-CENTERED CUBIC METALS. PART TWO—EXPERIMENTAL INVESTIGATION. E. Anderson and J. Spreadborough (Battelle Memorial Inst. International Div., Geneva). Nov. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 095-12-RDS. 74p.

The results of detailed metallographic observations (including measurements of twin frequency) on Armco iron samples deformed in tension under various experimental conditions are presented and discussed. For fine-grained specimens, it was found that twinning can occur and be unconnected with brittle fracture. Twin formation is a secondary mode of deformation, and occurs virtually at the front of a propagating Lüders band. Twinning takes place preferentially in the largest grains in a typical cross-section, and the percentage twinning increases with increase in yield stress (with decrease in temperature or increase in strain rate). The twinning in fine-grained samples is explained in terms of a simple yield propagation model. For coarse-grained specimens, the twinning behavior may be explained similarly, but there is the added complication of brittle fracture intervening in the deformation process. Etch-pit studies showed that there is a stress concentration associated with the tip of a twin and that it may be relieved by slip or twinning in the neighborhood of the point of contact when the tip strikes a grain boundary or another twin. Evidence is also given in support of the emissary dislocation concept. It was concluded that twinning precedes brittle fracture, but it is not certain that twins are the cause of brittle fracture except in samples tested below the ductile-brittle transition temperature. The deformation behavior of Armco iron with particular reference to twinning is tabulated. (auth)

14464 (IS-762) THE FERMI SURFACE OF LEAD. James Robert Anderson and A. V. Gold (Ames Lab., Ames, Iowa). Nov. 1962. Contract W-7405-eng-82. 237p.

Thesis submitted by James Robert Anderson to Iowa State Univ., Ames.

Knowledge of the Fermi surface is one of the most important requirements for understanding the properties of a metal. A very powerful tool for studying this surface is the de Haas-van Alphen effect, the oscillations in the magnetic susceptibility with magnetic field found in metal single crystals at very low temperatures. The de Haas-van Alphen effect in lead was previously studied using pulsed magnetic fields up to a maximum of 80 kG. The results indicated that the Fermi surface was much like a free-electron surface, and that valuable additional information should become available by extending the measurements to higher fields. An apparatus was designed and constructed to extend the magnetic fields to 200 kG. With the aid of these higher fields many new features of the Fermi surface in lead were quantitatively determined. The shape of the Fermi surface can be well explained in terms of an orthogonalized-plane-wave model using only two parameters, the two Fourier components of the pseudopotential, V_{111} and V_{200}. While the orthogonalized-plane-wave approach is successful in describing the shape of the Fermi surface, the calculated cyclotron masses are too small by a factor of order two. The theoretical implications of this are discussed briefly. The de Haas-van Alphen oscillations were observed in iron whiskers. This is the first time that the effect was observed in a ferromagnetic metal. Preliminary results show that the saturation magnetization in iron must be taken into account in order to determine the true periods of the oscillations. (auth)

14465 (KAPL-2296) EFFECT OF COMBINED STRESS ON ELASTIC, PLASTIC-FLOW, AND FRACTURE BEHAVIOR OF EXTRUDED ZIRCALOY-2 AND EXTRUDED ZIRCALOY-4 AT 580°F. S. H. Miller and John Swota, Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Oct. 10, 1963. Contract W-31-109-eng-52. 45p.

The elastic, plastic flow, and fracture characteristics of an extruded Zircaloy-2 and an extruded Zircaloy-4 material were investigated as a function of stress state, using thin-walled cylindrical specimens subjected to various

combinations of axial tension, internal pressure, and external pressure. Constant-stress-ratio tests were conducted at stress states varying from uniaxial tangential tension to combined axial tension plus tangential compression. The mechanical properties of the extruded Zircaloy-2 and Zircaloy-4 materials were found to be similar. These materials exhibited highly anisotropic elastic and plastic flow behaviors. The specimens ruptured at the positive stress ratios, and exhibited noticeable fracture anisotropy. The negative stress ratio tests were not conducted to fracture. A mathematical expression was used to correlate the anisotropic elastic behaviors, and graphical analyses were used to correlate the anisotropic plastic flow and fracture data. It was found that for positive stress ratios, the fracture ductility, (expressed as the numerically largest logarithmic fracture strain), and the true average fracture stress, (expressed as effective stress), decreased with increasing biaxiality. The minimum fracture ductility at 580°F was 40%. A comparison of the uniaxial flow behaviors obtained for these extruded materials to the uniaxial flow properties of rolled Zircaloy-4 plate, tested parallel and transverse to rolling, indicated that the extruded materials were noticeably more anisotropic than the rolled material. However, the manner in which the degree of anisotropy varied with deformation was found to be similar for the extruded and rolled materials. (auth)

14466 (LA-2989) HOMOGENIZATION OF GALLIUM-STABILIZED DELTA-PHASE PLUTONIUM. Kaye Allan Johnson (Los Alamos Scientific Lab., N. Mex.). Nov. 1963. Contract W-7405-eng-36. 43p.

The homogenization behavior of cast gallium-stabilized delta plutonium was investigated and characterized by metallographic and electron microprobe techniques. Approximate diffusion data for gallium in delta plutonium were calculated from parameters of the homogenization process. For comparison, the homogenization behavior of rolled, relatively impure gallium-stabilized delta plutonium was investigated. The effects of heat treatment in the epsilon temperature region and cooling through the delta-plus-epsilon field were also investigated. (auth)

14467 (TID-7676(p.63-7)) FISSION GAS RELEASE FROM URANIUM CARBIDE POWDER. Allan Auskern (Brookhaven National Lab., Upton, N. Y.).

Isothermal diffusion anneals were performed at 185 to 1400°C on lightly irradiated uranium carbide powders. The rate of fission gas release was measured by periodically collecting the evolved gas and counting the Xe^{133}. At the end of an experiment the uranium carbide powder was dissolved and the remaining Xe^{133} determined. At high temperatures the gas release could be described quite well by diffusion kinetics. At low temperatures the amount of fission gas released was much greater than amounts calculated from extrapolated high-temperature diffusion data. A model was developed to account for this. (M.C.G.)

14468 (TID-7676(p.99-100)) CARBIDE RESEARCH AS RELATED TO THERMIONIC APPLICATIONS. A. F. Weinberg, L. Yang, F. D. Carpenter, and R. G. Hudson (General Atomic Div., General Dynamics Corp., San Diego, Calif.).

The physicochemical properties of mixed carbides of uranium and zirconium were measured to determine the usefulness of these materials as nuclear-heated thermionic emitters or as the nuclear fuel for refractory-metal thermionic cells. Property measurements of other carbide systems having potential as thermionic emitters were also performed. (auth)

14469 (TID-7676(p.101-4)) THERMOPHYSICAL PROPERTIES OF SOME CARBIDES AT HIGH TEMPERATURES. Summary and Conclusions. Leonard N. Grossman (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.).

Four thermophysical properties (thermal conductivity, electrical resistivity, total hemispherical thermal emittance, and normal spectral thermal emittance at 0.65 μ) may be measured simultaneously on an apparatus designed and built partially under this program. The apparatus is useful in the temperature range from the onset of measurable thermal emission (about 1000°K) to an upper limit set by sublimation or decomposition of the specimen. The apparatus was used to specimen temperatures of over 2500°K. All thermophysical property experiments undertaken for this program, together with the degree of success realized, are summarized in tabular form. Values obtained for the various properties and the temperature range over which the values are valid are presented. The error limits reported are 95% confidence limits, valid over the temperature range reported. Electrical resistivity and thermal conductivity values are given for fully dense material. (auth)

14470 (TID-7676(p.121-7)) STUDIES WITHIN THE SYSTEM UC–UC_2. I. PHASE STUDIES. Willard G. Witteman and Melvin G. Bowman (Los Alamos Scientific Lab., N. Mex.).

Phase studies are being made on uranium carbide. Melting data, congruent composition, miscibility gap, the UC_2–C eutectic, and the UC_2 and UC phases are discussed. (M.C.G.)

14471 (TID-7676(p.128-34)) STUDIES WITHIN THE SYSTEM UC–UC_2. II. THERMODYNAMIC PROPERTIES OF URANIUM CARBIDES. Melvin G. Bowman and Milton C. Krupka (Los Alamos Scientific Lab., N. Mex.).

Thermodynamic properties of uranium carbides are being studied. Results are summarized. It was concluded that the 3 uranium carbides do not exhibit wide differences in thermodynamic stability. (M.C.G.)

14472 (TID-7677(p.7-15)) RELEASE OF FISSION PRODUCTS ON THE IN-PILE MELTING OR BURNING OF REACTOR FUELS. R. P. Shields, W. E. Browning, Jr., C. E. Miller, Jr., and B. F. Roberts (Oak Ridge National Lab., Tenn.).

In-pile experiments are being conducted to study the release of fission products during simulated reactor accidents. One type of experiment consisted of melting or vaporizing a miniature stainless steel-clad UO_2 fuel element in a helium atmosphere. In the other type, a miniature fuel element composed of spheroidal particles of uranium carbide coated with pyrolytic carbon and embedded in a graphite matrix was burned in air. Results are shown in tables and graphs. (M.C.G.)

14473 (TID-20221) METASTABLE AMORPHOUS PHASES IN TELLURIUM-BASE ALLOYS. Technical Report No. 22. Huey-Lin Luo (California Inst. of Tech., Pasadena) and W. M. Keck (Lab. of Engineering Materials). Jan. 1964. Contract AT(04-3)-221. 30p.

Amorphous phases were found in tellurium base alloys very rapidly cooled from the liquid state. These phases, which are stable at room temperature, exist in binary alloys containing from approximately 10 to 25 at. % germanium, and from 10 to 30 at. % of gallium or indium. The structure of these alloys was studied by x-ray diffraction (Debye-Scherrer method), using molybdenum Kα radiation monochromatized by the (200) plane of a lithium fluoride

crystal. Radial distribution functions were obtained and within the experimental accuracy neither the nature of the alloying element nor its concentration had a noticeable effect on the shape of the distribution function. The atomic arrangement in the amorphous alloys is very similar to that found in liquid tellurium which is itself closely related to the crystal structure of solid tellurium. (auth)

14474 (TID-20264) AN INVESTIGATION OF THE ELECTRONIC STRUCTURE OF SINGLE CRYSTAL MAGNESIUM OXIDE USING THE TECHNIQUE OF HIGH ENERGY ELECTRON BOMBARDMENT. Technical Report No. 1. David L. Bowler (Bartol Research Foundation, Swarthmore, Penna.). Feb. 10, 1964. Contract AT(30-1)-2730. 116p.

Bombardment by high-energy electrons enhances the conductivity of single-crystal magnesium oxide. Following bombardment, the conductivity is observed to decay. In this work, attention was given to understanding the mechanism of decay at temperatures in the range near 100°C. It is shown that the bombardment creates and fills traps and that the observed conductivity is due to carriers which are thermally ejected from the traps. A model incorporating a single trap level is proposed and it is shown that the decay curves are satisfactorily explained on this basis, and that the energy of the trap may be determined from a series of decay measurements. Two crystals from different sources are used in the experiments. In both crystals a trap level having an energy near 1 ev is principally responsible for the post-bombardment conductivity. By using the results of thermal glow curve measurements in connection with the trap energy determined from the model, the carrier mobility is estimated as about 1 cm^2/volt-sec at room temperature. It is pointed out that certain of the results are in qualitative agreement with previously reported measurements. (auth)

14475 (TID-20304) THE STRUCTURE OF LIQUID COPPER, SILVER, TIN, AND MERCURY. Technical Report No. 4. C. N. J. Wagner, H. Ocken, and M. L. Joshi (Yale Univ., New Haven. Hammond [Metallurgical] Lab.). Jan. 1964. Contract AT(30-1)-2560. 52p.

The x-ray scattering of liquid Cu, Ag, Sn, and Hg was measured using a theta-theta diffractometer, i.e., Bragg-Brentano focusing geometry with a horizontal, stationary sample. Mo Kα radiation was obtained by reflection of the x rays from a quartz crystal placed in the diffracted beam. Liquid Sn and Hg were also measured using the non-focusing, fixed x-ray beam, stationary sample method. In this case, monochromatization of the Mo radiation was achieved with a Zr–Y balanced filter system placed in the diffracted beam. The measured intensities in electron units, I_{eu}, of Ag, Sn, and Hg agree very well with recently published results. The data obtained with the θ-θ diffractometer are more reliable since the absorption correction is eliminated when the sample is properly positioned with respect to the diffractometer axis. Crystal monochromatized radiation leads to lower statistical fluctuation of the intensity (1% with θ-θ diffractometer) than radiation monochromatized by using a balanced filter technique (4% with non-focusing method) for the same counting time. The intensity data were analyzed with a program compiled for use with an IBM 709 computer. The radial distribution functions $4\pi r^2\rho(r)$ of Cu, Ag, Sn, and Hg were evaluated. The interatomic distances r_1 obtained from the atomic distribution function $W(r) = \rho(r)/\rho_0$, where ρ_0 is the average atomic density, are 2.55 A for Cu at 1125°C, 2.84 A for Ag at 1050°C, 3.14 A for Sn at 335°C, and 3.05 A for Hg at 28°C. The coordination numbers are approximately 11.5 for Cu, 11.5 for Ag, 8.5 for Sn, and 10.0 for Hg. (auth)

14476 (TM-62-10-14) EFFECT OF MICROSTRUCTURE AND COMPOSITION ON THE PHYSICAL PROPERTIES OF BeO. R. E. Fryxell and B. A. Chandler (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Oct. 17, 1962. Contract AT(40-1)-2847. 40p. (CONF-92-2)

From American Ceramic Society 15th Pacific Coast Regional Meeting, Seattle, Oct. 1962.

The following properties were measured for extruded and isostatically pressed AOX grade BeO and MgO-containing UOX grade BeO: thermal expansion, elastic constants, rupture, strength, and compressive creep. The differences in the properties are discussed and interpreted in terms of grain size and preferred grain orientation. (D.L.C.)

14477 (UCRL-7595) A STUDY OF THE EFFECT OF ALLOYING ON THE GAMMA-PHASE STABILITY OF URANIUM USING VACUUM DIFFERENTIAL THERMAL ANALYSIS. C. A. W. Peterson and W. J. Steele (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 12, 1963. Contract W-7405-eng-48. 50p.

A simple, automatic, high-temperature, high-vacuum thermal analysis apparatus based on the differential method is described. Using samples of a few grams heated and cooled over a range of 1000°C in a vacuum of 10^{-5} torr, the phase transformations of a series of alloys of uranium with the elements molybdenum, niobium, and zirconium were determined. By this method the effects of the addition elements upon the gamma-phase stability of the uranium under low rates of thermal change were recorded. It was found that the three addition elements, molybdenum, niobium, and zirconium, rank in that order in ability to stabilize the gamma phase of uranium. (auth)

14478 (UCRL-10581) PREDICTION OF ACTIVATION ENERGIES FOR SELF-DIFFUSION IN METALS. Louis E. Toth and Alan W. Searcy (California. Univ., Berkeley and California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 15, 1963. Contract W-7405-eng-48. 16p.

A model of self-diffusion is developed in which the activation energy to form a vacancy Q_v is correlated with the heat of sublimation L_s, and the activation energy to move a vacancy Q_m, is correlated with either the melting temperature T_m or with the product of the bulk modulus B_s and the atomic volume V_o. The resulting equations for the activation energy for diffusion Q_D in face-centered metals are $Q_D = 22.6\ B_sV_o + 9.27\ L_s$ and $Q_D = 16.0\ T_m + 0.27\ L_s$ with similar equations for bcc elements. The results of these equations are compared to the experimental results for Q_m, Q_v, and Q_D and the agreement is found to be better than that obtained with previous correlations. Desirable features of the correlation equations are that they employ only readily measured parameters, that they predict not only Q_D but also Q_m and Q_v, and that they can be readily generalized to describe diffusion in substitutional alloys. (auth)

14479 (UCRL-10674) CLUSTERING OF VACANCIES AND HARDENING. G. Thomas and J. Washburn (California. Univ., Berkeley. Lawrence Radiation Lab.). Feb. 1963. Contract W-7405-eng-48. 80p.

A review is presented of clustered vacancies and the factors involved in their precipitation, annihilation, and hardening effect. The formation of clusters and nucleating conditions are discussed. Helical and radioinduced dislocations are considered. Growth mechanisms and climb are discussed. Finally, the effect of vacancy clustering on mechanical properties and theories of hardening are considered. Analysis of dislocation loops is described. (D.L.C.)

14480 (WAPD-275) EFFECT OF HYDROGEN AND HYDRIDE MORPHOLOGY ON THE TENSILE PROPERTIES OF ZIRCALOY-2. W. J. Babyak, W. F. Bourgeois, and G. J. Salvaggio (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Nov. 1963. Contract AT-11-1-GEN-14. 48p.

The effects of both hydrogen concentration and hydride morphology on the tensile properties of both alpha-annealed and beta-quenched Zircaloy-2 were experimentally determined at room temperature and at 500°F in order to assess the critical hydrogen level that would limit the useful lifetime of Zircaloy-2 in pressurized water reactors. Three hydrogen levels, approximately 15, 275, and 550 ppm, with the precipitated hydride either predominantly at grain boundaries or uniformly distributed within the grains, were investigated. Based on a comparison of the tensile strength of notched and unnotched specimens and an evaluation of the ductility values, the limiting hydrogen content of Zircaloy with grain boundary hydrides is 250 ppm. In general, the deleterious effects of hydrogen are less pronounced when the hydrides are uniformly distributed; therefore, under these conditions the limit can be extended to greater than 250 ppm. (auth)

14481 (AEC-tr-6344) CONDUCTIVITY AND HALL CONSTANT. IV. COPPER–NICKEL ALLOYS. Werner Koester and Wolfgang Schuele. Translated for Oak Ridge National Lab., Tenn., from Z. Metallk., 48: 592-4(1957). 10p.

The electrical resistance and the Hall constant of paramagnetic copper–nickel alloys of up to 45% Ni were measured as a function of thermal and mechanical pretreatment. The density and mobility of the charge carriers were calculated. In the recrystallized samples, a change of state occurs under 650°C, which is characterized by an increase in electrical conductivity and effective charge-carrier density as well as by a decrease of the Hall constant and the effective mobility. The Hall constant increases with increasing nickel content. The change of state thus results in a reduction of the influence of the alloying element. This indicates a [negative] short-range order in the solid solution. The neighbor relationships of the atoms are transformed in such a manner, that the electron exchange between the different atomic species is weakened. Cold-working increases or decreases the resistance and decreases the Hall constant. During annealing, both values drop to a minimum at about 450°C. The decrease is essentially the result of the [negative] short-range ordering. Subsequently, the value of the solid solution state is reattained by re-formation and recrystallization (auth)

14482 (AEC-tr-6347) INVESTIGATION ON VACANCIES AND PHASE SEPARATION IN THE SYSTEM COPPER–NICKEL BY MEANS OF THE ELECTRICAL RESISTANCE. Wolfgang Schuele and Hans-Peter Kehrer. Translated for Oak Ridge National Lab., Tenn., from Z. Metallk., 52: No. 3, 168-79(1961). 40p.

The temperature dependency and temperature coefficient of the electrical resistance up to 1000°C was investigated in six Cu–Ni alloys. Alloys with 34 to 55 at.% Ni have a negative temperature coefficient of electric resistance between room temperature and about 300°C. Above this temperature, the electrical resistance increases due to the re-formation of phase separation and formation of vacancies. Due to these two processes, the temperature coefficient of the alloys at room temperature is not substantially varied. The formation energy of vacancies for an alloy with 30 at.% Ni was found to be 0.93 ev. The activation energy of the migration of vacancies was found to be 1.10 ev independent of the alloy concentration. On the basis of the resistance increase with temperature above 600°C according to an e-function, the agreement of the sum of the activation energy for the formation and migration of vacancies with the value of the activation energy of self-diffusion, and the occurrence of dislocation rings after quenching from high temperatures and annealing, proof is brought that changes in the properties investigated are caused by vacancies. (P.C.H.)

14483 (EURAEC-317) FABRICATION OF UO_2 AND UO_2–BeO MIXED PELLETS. Quarterly Report No. 5, January 1–March 31, 1962. (Battelle Institut e. V., Frankfurt am Main). Apr. 13, 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract 015-60-9 RDA. 23p. (A translation)

The thermal expansion of UO_2 and UO_2–BeO sinters was determined up to 1100°C. It is not perfectly clear from the results whether the thermal expansion is directly dependent on the BeO content. Slight fluctuations in the values obtained are within the degree of accuracy to be expected. X-ray microstructure tests carried out to determine the lattice constants of UO_2 in order to ascertain whether small amounts of BeO are incorporated in the UO_2 lattice during sintering showed that there was no noticeable change in the UO_2 lattice constants. Tests on microscopic sections showed that the BeO was uniformly distributed in the UO_2. The BeO particles break out during grinding and polishing and display a false porosity, which appears to increase as the BeO content is stepped up. The heat-conductivity tests on UO_2–BeO mixed samples were concluded and evaluated. The results indicate that the heat conductivity increases in proportion to the BeO content. The addition of 20 vol % BeO resulted in the heat conductivity being doubled as opposed to pure UO_2 sinters. The average relative error in the determination of the heat conductivity totaled $\Delta\lambda/\lambda \pm 8\%$. (auth)

14484 (EURAEC-869) STUDY OF A FEW METAL OXIDATION PROBLEMS AND APPLICATION OF IMPEDANCE MEASUREMENT METHODS TO THE STUDY OF CORROSION RESISTANCE IN WATER. Quarterly Report No. 6, July 1 to September 30, 1963. (Brussels. Universite). Work Performed under United States–Euratom Joint Research and Development Program. Contract 081-62-5 RDB. 15p. (A translation)

The selective oxidation reaction of the copper contained in gold-copper alloys with a very low copper content (1 and 7 at. %) may occur by localized germination and growth of copper oxide crystals. The conditions of oxide seed formation are defined and supplemented with data. Oxidation is studied with respect to the nature and structure of induction films and layers containing well-developed seeds. A study of the oxidation of copper shows that cupric oxide appears only after the formation of cuprous oxide when the oxidation rate decreases to a certain critical value. (N.W.R.)

14485 INFLUENCE OF SOME VARIABLES OF PRECIPITATION FOR PEROXIDES OF URANIUM ON THE SURFACE ACTIVITY OF THE RESULTING OXIDE. J. A. Alonso, S. Cordero, F. Carrasco, and E. Aparicio (Junta de Energia Nuclear, Madrid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 59: 619-22(Sept.-Oct. 1963). (In Spanish)

The principal advantages of the use of ceramic nuclear fuels, the efforts toward cost reduction in manufacturing processes, and the fulfilment of specifications are considered. Surface area is one of the parameters affecting

the sintering process of UO_2 fuels and some of the findings obtained in studying this property at the precipitation and calcination stages are presented for the peroxide method. The aim was to investigate, not only the influence of the precipitation parameters (pH, uranium content, and temperature) on the surface area of the calcined trioxides, but also the reproducibility of the results. (auth)

14486 HAYNES ALLOY Cb-752 (HIGH TEMPERATURE ALLOY). Alloy Dig., Cb-6, 2p.(Nov. 1963).

Haynes alloy Cb-752 is a Cb base alloy containing 10% W and 2.5% Zr, which has good high temperature characteristics. Data on specific gravity; specific heat; thermal expansion and conductivity; modulus of elasticity; hardness; notch tensile properties; tensile properties, bearing strength, and shear strength at room and elevated temperatures; creep and stress rupture properties; and procedures for heat treating, machining, working, and TIG welding are given. (Rev. Metal Lit., 21: No. 2, Feb. 1964)

14487 A LIGAND FIELD TREATMENT OF THE ZIRCONIUM–OXYGEN CRYSTAL. Bjoern Roos. Arkiv Fysik, 25: 363-80(1964).

A localized orbital method was used in order to calculate the cohesive energy of the zirconium–oxygen system. The crystal environment is described by means of a ligand field potential in a point charge approximation. In this model the cohesive energy is calculated as a function of the two lattice parameters and the charge of the oxygen ions, for different amounts of oxygen in the crystal. The one-electron orbitals for the valence electrons of the zirconium atoms are determined by means of an effective one-electron hamiltonian. A basic set of 16 orbitals of type s, p, d, and f was used. The oxygen ions are treated as point charges. The calculated values of the lattice parameters are in good agreement with experimental results. According to the results the charge on the oxygen ions increases from 1.4 electrons for small oxygen content to about 2 electrons at the limiting composition Zr_3O, for the treated crystal structure. (auth)

14488 CERAMIC OXIDE MELTS AS SOLVENTS FOR FISSIONABLE MATERIAL OF HOMOGENEOUS HIGH-TEMPERATURE NUCLEAR REACTORS. Klaus Johannsen (Technische Universität, Berlin). Atomkernenergie, 9: 54-61(Jan.-Feb. 1964). (In German)

The solvents for fissionable materials, proposed and investigated so far, for application in homogeneous nuclear reactors are discussed. The feasibility of using ceramic oxides in homogeneous high-temperature nuclear reactors is considered. It was concluded that oxyceramic melts should be useful as solvents for the fissionable material as well as heat transfer media and they will make it possible to reach temperatures of 2200°C and above. The investigation of the high-melting inorganic oxides for determining their nuclear, heat-transfer, and chemical properties led to borate melts of the B^{11} isotope with admixtures of BeO, $^7Li_2O$, and MgO for medium temperatures up to about 1600°C and to melts of BeO–MgO or BeO–MgO–Al_2O_3 for temperatures of at least 2200°C. The concentrations of the fissionable material UO_2 essential for the preservation of a self-sustaining chain reaction are in the range of 0.5 to 3 wt % in accordance to the enrichment. (auth)

14489 THE EFFECTS OF CARBIDES ON THE MECHANICAL PROPERTIES OF TANTALUM. H. R. Ogden, F. F. Schmidt, and E. S. Bartlett. Can. Met. Quart., 2: 355-68(Oct.-Dec. 1963).

Carbon additions were found to strengthen Ta and Ta-base alloys at the temperatures at which they form stable carbides. In conjunction with concurrent Zr additions, the structural nature of the carbide phase may be altered although it seems to have little effect on the strength. At very high temperatures (above 3000°F) the carbon solubility in Ta increases rapidly with temperature and even the reactive metal carbides dissolve in Ta and lose their effectiveness. (Rev. Metal Lit., 21: No. 2, Feb. 1964)

14490 EVIDENCE OF PLASTICITY OF TUNGSTEN MONOCARBIDE. Jacques Corteville and Louis Pons. Compt. Rend., 257: 1915-18(Sept. 23, 1963). (In French)

Determination was made of cold deformation, plasticity, fissure resistance, and sliding plane orientation of sintered and mechanically polished WC crystals by Vickers microhardness test and Vickers ray micrography. (Rev. Metal Lit., 21: No. 1, Jan. 1964)

14491 MELTING DIAGRAM OF THE SYSTEM CaO–Al_2O_3–ZrO_2. A. S. Berezhnoi (Academy of Sciences, Ukrainian SSR) and R. A. Kordyuk. Dopovidi Akad. Nauk Ukr. RSR, No. 10, 1344-7(1963). (In Ukrainian)

Coexistent phases in the system CaO–Al_2O_3–ZrO_2 were determined. A new compound $Ca_7Al_6ZrO_{18}$ was found with the following properties: density 3.10 g/cm^3, melting point 1550°C, coefficient of thermal expansion $8.7 \cdot 10^{-6}$; N_g = 1.710; N_m = 1.707; N_p = 1.705; 2V = 53.1°; it is biaxial positive, formed from oxides in the solid phase with increase in volume approximately by 24 pC through binary compounds ($CaZrO_3$ and $CaAl_2O_4$); and it reacts with water. X-ray characteristics of the compound are given. The melting diagram of the system CaO–Al_2O_3–ZrO_2 is established and the areas containing not more than 10 pC of the melt at 1600°C are found on its basis by calculation. This system is characterized by near location of the melting curve of 1600°C to $CaZrO_3$ and even to ZrO_2, which prevents the use of its ternary compounds in refractory technology. (auth)

14492 RESISTIVITY MEASUREMENTS ON HIGHLY RESISTIVE SILICON. G. P. Bolognesi (SEMEL S.p.A., Milan), A. Pierno, and G. Redaelli. Energia Nucl. (Milan), 11: 18-22(Jan. 1964).

A 4-points probe for resistivity measurements on Si (ρ > 100 ohm cm), especially useful for thin slices as used in radiation detectors, was built. A series of measurements on different samples allowed correction factors for use on particularly thin slices to be determined. (auth)

14493 COMPATIBILITY OF IRIDIUM WITH OTHER HIGH TEMPERATURE MATERIALS AT ELEVATED TEMPERATURES. E. D. Zysk, D. A. Toenshoff, and J. Penton. Engelhard Ind. Tech. Bull., 4: 52-8(Sept. 1963).

Specimens of Ir were heated in contact with tungsten and zirconia in argon and a vacuum to temperatures near the melting point of Ir to determine their compatibility. Data are given on the physical and mechanical properties of Ir, the elevated temperature characteristics of Ir and Ir alloys, and their compatibility with other high temperature materials. (Rev. Metal Lit., 21: No. 1, Jan. 1964)

14494 PHOTOELECTRIC AND THERMIONIC SCHOTTKY DEVIATIONS FOR TUNGSTEN SINGLE CRYSTALS. D. F. Stafford and A. H. Weber. J. Appl. Phys., 34: 2667-70(Sept. 1963).

Periodic Schottky deviations were obtained for photoelectric and thermionic emission from a tungsten single crystal at high electric fields and temperatures and were compared with a composite theory. The photoelectric deviations are in fair agreement in period and phase with the thermionic deviations, the agreement being better at larger applied electric fields. (Rev. Metal Lit., 21: No. 1, Jan. 1964)

14495 ELECTRONIC CONDUCTION IN SINGLE CRYSTALS OF URANIUM DIOXIDE. P. Nagels, J. Devreese, and M. Denayer (Centre d'Etude l'Energie Nucléaire, Mol, Belg.). J. Appl. Phys., 35: 1175-80(Apr. 1964).

Electrical conductivity measurements between 90 and 800°K were performed on single crystals of uranium dioxide with compositions in the range $UO_{2.000}$ to $UO_{2.007}$. The activation energy calculated from the $\ln\sigma T$ vs $1/T$ curves decreases from 0.34 to 0.19 ev with increasing excess oxygen content. Hall effect measurements by d-c and a-c techniques yielded no measurable response, and indicate that the Hall mobility is smaller than 0.015 cm^2v^{-1} sec^{-1} at room temperature. This result and a consideration of the fundamental parameters determining the transport mechanism suggest an interpretation based on small polaron theory. (auth)

14496 PARAMAGNETIC SUSCEPTIBILITY OF Eu_2O_3 FROM 300° TO 1300°K. Sigurds Arajs and R. V. Colvin (United States Steel Corp., Monroeville, Penna.). J. Appl. Phys., 35: 1181-3(Apr. 1964).

The magnetic susceptibility of Eu_2O_3 was studied as a function of temperature between 300 and 1300°K. The results can be satisfactorily explained by the Van Vleck theory of paramagnetism with Judd's energy levels of free Eu^{3+} ions. (auth)

14497 INFLUENCE OF TEMPERATURE, STRAIN RATE, SURFACE CONDITION, AND COMPOSITION ON THE PLASTICITY OF TRANSITION-METAL CARBIDE CRYSTALS. Wendell S. Williams (Union Carbide Corp., Parma, Ohio). J. Appl. Phys., 35: 1329-38(Apr. 1964).

A fundamental study of the ductile-brittle behavior of the transition-metal monocarbides was initiated through an investigation of the plastic deformation of single crystals of TiC, ZrC, and NbC. A vacuum furnace was used with an Instron testing machine for compression measurements in the temperature range 800 to 1600°C. The specimens were Linde single-crystal boules, cleaved into bars approximately 1 × 1 × 4 mm. The compressive stress was applied longitudinally in a ⟨100⟩ direction in the NaCl structure. The three carbides studied behaved similarly, but NbC was several times harder than TiC and ZrC. The critical resolved shear stress decreases exponentially with increasing temperature, increases approximately linearly with increasing carbon content, is little affected by surface condition, and increases as the logarithm of the strain rate. No yield point was observed. The effective stress exponent depends on the strain rate, ranging from 1 to 10. These results are discussed in relation to recent theories of the stress-strain relation. (auth)

14498 HIGH-TEMPERATURE HEAT CONTENT OF TUNGSTEN CARBIDE AND HAFNIUM CARBIDE. L. S. Levinson (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 40: 1437-8(Mar. 1, 1964). (LADC-6078)

The heat content of tungsten carbide was measured between 1276 and 2642°K and that of hafnium carbide between 1286 and 2805°K using a drop calorimeter. (auth)

14499 THE URANIUM–MOLYBDENUM–CARBON EQUILIBRIUM DIAGRAM. F. G. Streets and J. J. Stobo (International Research and Development Co., Ltd., Newcastle upon Tyne, Eng.). J. Inst. Metals, 92: 171-4(Feb. 1964).

The uranium corner of the ternary uranium-molybdenum–carbon equilibrium diagram up to 45 at.% C, 25 at.% Mo, and 800°C was drawn as the result of metallographic and x-ray examination of quenched alloys. Carbon when added to uranium–molybdenum alloys removes uranium from the metallic matrix by forming UC and enriches the matrix in molybdenum. The solubility of molybdenum in UC at 650°C is estimated at 1.8 ± 0.6 at.%. (auth)

14500 AN INVESTIGATION OF THE COPPER-RICH PORTION OF THE COPPER–ZIRCONIUM PHASE DIAGRAM BY ELECTRON-PROBE MICROANALYSIS. Matthew J. Donachie, Jr. (Chase Brass and Copper Co., Inc., Waterbury, Conn.). J. Inst. Metals, 92: 180(Feb. 1964).

Studies were made on the composition of the intermediate phase, the terminal solid solution, and eutectic in Cu–Zr alloys using mainly electron-probe microanalysis. Examination of four alloys containing >16.4% Zr established a Zr composition of 26.2–29.8%, with an average of 28.1%, and a copper composition of 71.2–73.6%, with an average of 72.5%, for the first intermediate phase. The results indicate that Cu_4Zr is the first intermediate phase in the system, although there must be a range of solubility associated with it. The copper-rich terminal solid-solution phase was examined in a series of alloys containing 11.3% Ar. The maximum concentration value observed was 0.17% Zr. Thermal analysis indicated a eutectic temperature of 970°C. (P.C.H.)

14501 KINETICS OF YIELD-POINT RETURN IN UNALLOYED TUNGSTEN. W. R. Baird and C. S. Hartley (Wright Air Development Center, Wright-Patterson AFB, Ohio). J. Inst. Metals, 92: 181-2(Feb. 1964).

The kinetics of yield-point return in commercially pure W were determined. The activation energy for yield-point return is of the order of 96 kcal/mole. The results demonstrate that yield-point return in impure W can occur by a process other than interstitial pinning of free dislocations. The kinetics of the process and metallographic observations support the hypothesis that dislocations are immobilized by polygonization or removed by migration to large-angle grain boundaries. (P.C.H.)

14502 THE APPEARANCE OF COLUMNAR GRAINS IN A URANIUM–CHROMIUM ALLOY. A. Bar-Or and P. Wynblatt (Israel Atomic Energy Commission, Tel-Aviv). J. Inst. Metals, 92: 183-4(Feb. 1964).

A study was made to investigate the influence on the grain size of isothermal heat-treatment at temperatures between 600°C and the eutectoid transformation temperature in Cr–U alloys. It was established that the columnar grains: appear isothermally in the U–0.45 at.% Cr alloy on transformation at temperatures between 635 and 600°C; and do not appear either in pure U, or below 600°C in the alloy. It is believed that the factor responsible for the appearance of columnar grains is the difference between the nucleating rate at the surface and that in the bulk of the sample, at high transformation temperatures. (P.C.H.)

14503 FINE-GRAIN STRUCTURE IN A CO-EXTRUDED MAGNESIUM–0.5% ZIRCONIUM ALLOY. Shotaro Morozumi and Shigeyaso Koda (Tohoku Univ., Sendai). J. Inst. Metals, 92: 192(Feb. 1964).

The observation of fine-grain structure in co-extruded Mg and Mg–Zr alloy was investigated. It was concluded that the anomalous fine-grain structure results from a difference in the deformation behavior of that portion of the alloy that is hot worked in contact with softer materials. (P.C.H.)

14504 CERTAIN REGULARITIES IN THE CRYSTAL CHEMISTRY OF INTERMETALLIC COMPOUNDS OF THE RARE EARTH METALS. P. I. Kripyakevich, E. I. Gladyshevskii, O. S. Zarechnyuk, V. I. Evdokimenko, I. I. Zalut-

skii, and D. P. Frankevich. Kristallografiya, 8: 595-9 (1963). (In Russian)

Several properties of compounds of the rare earth metals are reviewed. Data on morphotropy of a large number of rare earth compounds are tabulated. Studies show that the structures of certain types of rare earth compounds are dependent on atomic radii of component atoms and the atomic number of the rare earth. (TCO)

14505 STUDY OF TERNARY SYSTEM W–Cb–Si. N. V. Dokukina and F. I. Shamray. Met., Metalloved., Fiz. Khim. Metody Issled., No. 12, 132-42(1963). (In Russian)

W–Nb–Si alloy ingots were prepared from high purity powders by argon arc melting, and homogenizing the ingots at 1000 to 1600°C. The influence of varied amounts of components on microstructure, microhardness, hardness, phase composition, electrical resistance, heat resistance, and melting points were determined. The phase diagrams for the WSi_2–$CbSi_2$ system and the W–Cb–Si system are given. (Rev. Metal Lit., 21: No. 2, Feb. 1964)

14506 CONSTITUTIONAL DIAGRAMS OF SYSTEMS MAGNESIUM–NEODYMIUM AND MAGNESIUM–CERIUM. M. E. Drits, Z. A. Sviderskaya, and L. L. Rokhlin. Met., Metalloved., Fiz. Khim. Metody Issled., No. 12, 143-51 (1963). (In Russian)

Solubility, phase composition, crystallization points, and microstructure of the Mg–Nd system, with Nd content up to 70%, were determined up to 750°C, and of the Mg–Ce system, with Ce content up to 40%, were determined up to 650°C. (Rev. Metal Lit., 21: No. 2, Feb. 1964)

14507 INTERACTION BETWEEN YTTRIUM AND OTHER METALS. E. M. Savitskii, V. F. Terekhova, I. A. Markova, and R. F. Filimonova. Metal Sci. Heat Treat. Metals (USSR) (English Transl.), No. 9-10, 392-6(Sept.-Oct. 1962).

A review of the physical and mechanical properties and general metallurgical characteristics of yttrium and of the interaction between yttrium and all the other elements of the periodic table is presented. Included are binary phase diagrams for yttrium and the other elements and results of experiments on the effect of yttrium additions to other elements and alloys on their properties and on the effect of additions to yttrium on its properties. The effect of purity is stressed. (Rev. Metal Lit., 21: No. 1, Jan. 1964)

14508 A NEW FEATURE IN THE METALLOGRAPHIC ETCHING OF NIOBIUM. R. S. Eary (Union Carbide, Ltd., London) and R. D. Johnston. Metallurgia, 69: 43-9(Jan. 1964).

Factors involved in the etching of niobium are discussed. Free hydrofluoric acid is required to be present solely as a means of dissolving the oxide film and etching then takes place by means of the ferric chloride. (auth)

14509 A NEW STRUCTURE IN THE MAGNESIUM-RICH REGION OF THE CERIUM–MAGNESIUM SYSTEM. Q. C. Johnson, Gordon S. Smith, D. H. Wood, and E. M. Cramer (Univ. of California, Livermore). Nature, 201: 600(Feb. 8, 1964).

Single-crystal techniques were used to determine the structure of $CeMg_9$. (R.E.U.)

14510 INVESTIGATION OF THE REGULAR COALESCENCE OF ALPHA-IRON, MOLYBDENUM AND ALPHA-TUNGSTEN WITH THEIR CUBIC NITRIDES. Helmut Gunther Schneider. Neue Huette, 8: 494-8(Aug. 1963). (In German)

Sheet specimens with large crystallites were fabricated by recrystallization of Fe, Mo, and W sheets and nitriding of the specimens in H_2/NH_3 gas mixtures at 550 to 1200°C. X-ray analysis was made of the orientation of the nitrides and kinetic considerations. (Rev. Metal Lit., 21: No. 2, Feb. 1964)

14511 THE TEMPERATURE DEPENDENCE OF THE DENSITY OF LIQUID METALS. S. W. Strauss (Naval Research Lab., Washington, D. C.). Nucl. Sci. Eng., 18: 280-5(Feb. 1964).

Methods and results of density-temperature determinations for 35 liquid metals are presented. 132 references. (R.E.U.)

14512 CONSIDERATIONS ON THE MECHANISM OF INERT-GAS DIFFUSION IN UO_2. R. L. Colombo (Fiat, Sezione Energia Nucleare, Turin). Nucl. Sci. Eng., 18: 285-7(Feb. 1964).

The diffusion mechanisms for xenon in UO_2 are discussed. (R.E.U.)

14513 SELENIUM: POSSIBLE RANKINE-CYCLE FLUID. C. F. Bonilla and G. Shulman (Columbia Univ., New York). Nucleonics, 22: No. 3, 58; 60(Mar. 1964).

The vapor pressure of selenium was measured to ten atmospheres. The vapor density and latent heat of vaporization were calculated. (R.E.U.)

14514 THE RELEASE OF FISSION PRODUCTS FROM A LEAKY FUEL ELEMENT. Krzysztof Zarnowiecki, Bogdan Filipiak, and M. Czerniewski. Nukleonika, 8: 601-6(1963). (In Polish)

Gaseous fission products behavior in the reactor fuel is discussed with special attention to the probable mechanism of fission gases release from the WWR-S reactor fuel elements. A theory is outlined to explain the observed release of fission products from a leaky fuel element. (auth)

14515 RESISTIVITY OF α PLUTONIUM UNDER PRESSURE AT LOW TEMPERATURE. R. Lallement (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Phys. Letters, 8: 166(Feb. 1, 1964). (In French)

Results are given of resistivity measurements for α–Pu at 4 to 200°K for normal pressure and for 2000 atm. (R.E.U.)

14516 EFFECT OF PREFERRED ORIENTATION ON THE ELECTRICAL RESISTIVITY OF ALPHA PLUTONIUM AT LOW TEMPERATURES. R. O. Elliott, C. E. Olsen, and S. E. Bronisz (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Letters, 12: 276-8(Mar. 16, 1964).

The electrical resistivity of monoclinic α-phase Pu was studied at 4 to 300°K for different polycrystalline grain structure orientations. (R.E.U.)

14517 ELECTRICAL RESISTIVITY OF POLYCRYSTALLINE GADOLINIUM FROM 4 TO 375°K. R. V. Colvin and S. Arajs (United States Steel Corp., Monroeville, Penna.). Phys. Status Solidi, 4: 37-42(1964).

Electrical resistivity of high purity polycrystalline gadolinium, with a residual resistivity of about 2.4 $\mu\Omega$ cm, was studied as a function of temperature between 4 and 375°K. Between 5 and 15°K, the intrinsic resistivity was proportional to T^n with $n = 3.73 \pm 0.03$. This value was close to the theoretically expected temperature dependence, T^4, of the magnetic resistivity as suggested by Mackintosh on the basis of a linear spin wave dispersion law. The electrical resistivity in the neighborhood of 210°K did not exhibit any anomaly of the type that would clearly support the existence of the ferromagnetic-antiferromagnetic transformation proposed by Belov and his co-workers. The detailed resistivity behavior at the Curie temperature, 293 ± 1°K, indicated a gradual transition from the ferromagnetic to the paramagnetic state. (auth)

14518 AN EMPIRICISM FOR ESTABLISHING THE TRANSITION TEMPERATURES OF SUPERCONDUCTING ALLOYS AND COMPOUNDS. L. Gold (Kennecott Copper Corp., Lexington, Ky.). Phys. Status Solidi, 4: 261-5(1964).

The preparation of superconductive alloys may be guided by a form of empiricism based upon the isotope law. For a series of alloys having a common structure, the critical temperatures of its members are presumed so interrelated. The reduced mass of a compound becomes somewhat obscure for stoichiometry other than 50 to 50 at. %. Several possible definitions of reduced mass permit setting of upper and lower bounds on the transition point in general. Theoretical calculations are presented for Nb_3In with evidence that the experimental values for this substance and Nb_3Ga may require slight revision. In line with the quest for alloys with higher critical temperatures than Nb_3Sn, a prediction is made that Nb_3Si (were it to exist and be of the β-tungsten structure) would be a promising prospect. (auth)

14519 A NEW METHOD FOR NEUTRON DIFFRACTION CRYSTAL STRUCTURE INVESTIGATIONS. B. Buras and J. Leciejewicz (Inst. for Nuclear Research, Swierk, Poland). Phys. Status Solidi, 4: 349-55(1964).

A neutron method for structure investigations of powdered crystals using time-of-flight techniques is described, and results presented for aluminum and silicon powders. The measured and calculated structure factors are in good agreement. The value of the method and its possible applications are discussed. (auth)

14520 ON DIFFUSION PHENOMENA IN HEAT-TREATED PYROGRAPHITE-COATED (U,Zr)C-NUCLEAR FUEL PARTICLES. F. Benesovsky, R. Theisen, and P. Stecher (Metallwerk Plansee AG, Reutte/Tirol, Austria and EURATOM, Ispra, Italy). Planseeber. Pulvermet., 11: 146-57(Dec. 1963). (In German)

In the ternary system uranium–zirconium–carbon at the monocarbide section, ranges are present within which the alloys are stable to carbon up to high temperatures. These alloys appear to be eligible as fuels in gas-cooled high-temperature reactors. They are applied in the form of sintered or molten spherical particles which are coated with pyrographite in a fluidized-bed process. During long-time annealing in vacuum of such coated fuel particles at temperatures above 2000°C, diffusion phenomena are observed. By means of electron-beam microanalysis it was possible, in addition to qualitative metallographic findings, to obtain quantitative data concerning the phases changes occurring in the kernel. The thickness of the diffusion layer in the pyrographite as well as the concentration distribution of uranium and zirconium, respectively, could be determined with high accuracy. It was concluded that uranium is slightly soluble in carbon. The cause of the instability of the kernels is to be sought in the formation of zone-mixed crystals during cooling of the melts, giving rise to ranges of uranium-rich unstable alloys. (auth)

14521 PARTICLE SIZE AND STRAIN IN DEFORMED TUNGSTEN. N. C. Halder and G. B. Mitra. Proc. Phys. Soc. (London), 82: 557-60(Oct. 1963).

Using variance as a measure of line broadening, average particle size and root mean square lattice strain in deformed tungsten were determined. Assuming the particles to be identical spheres, a particle size of 232 angstroms and a root mean square strain equal to 0.0032 were obtained. (Rev. Metal Lit., 21: No. 1, Jan. 1964)

14522 THE BEHAVIOR OF FISSION GASSES IN CERAMIC REACTOR MATERIALS. David L. Morrison (Battelle Memorial Inst., Columbus, Ohio). Reactor Mater., 6: No. 4, 1-10(Winter 1963-64).

Fission-gas behavior in ceramic material is discussed, with emphasis on the differences between the observed fission-gas release and that expected by a simple diffusional model of release. Experimental results for UO_2, UC, graphite, and ceramic oxides and other ionic crystals were examined. It is shown that the availability of gas ions for diffusion may be modified by surface or subsurface processes that give rise to variations in the rate of release from that expected from a strictly diffusional process. One cause of these variations may be the existence of trapping sites. (50 references). (M.C.G.)

14523 THE ELECTRONIC BAND STRUCTURE OF V_3Si AND V_3Ga. M. Weger (Univ. of California, La Jolla). Rev. Mod. Phys., 36: 175-7(Jan. 1964).

The nuclear magnetic relaxation of V^{51} in V_3Si and V_3Ga is used to determine the electronic band structure and crystal structure of these compounds. (T.F.H.)

14524 MODIFICATIONS IN THE CRYSTAL STRUCTURE PARAMETERS WITH TEMPERATURE AND THEIR INFLUENCE ON SOME PROPERTIES OF URANIUM. C. Nagabhushana Rao and K. Tangri. Trans. Indian Inst. Metals, 16: 93-103(June 1963).

The angle of corrugation in the a-c plane, bond lengths and bond orders, and sizes of interstitial holes in the structure of alpha uranium were calculated as functions of temperature. The bond-orders show that the change of principal slip system at higher temperatures is not a direct consequence of the change of bond orders with temperature. (Rev. Metal Lit., 21: No. 2, Feb. 1964)

14525 X-RAY ABSORPTION ANALYSIS OF MOLYBDENUM AND BERYLLIUM ALLOYS. V. N. Karev and N. N. Matyushenko (Inst. of Physics and Tech., Academy of Sciences, USSR). Zavodsk. Lab., 30: 44(1964). (In Russian)

An x-ray absorption analysis based on measuring the intensity of a beam passing through a plane-parallel specimen was used in order to verify the stoichiometric formula $MoBe_{22}$. The relative order of error is 6%. (tr-auth)

14526 INVESTIGATION OF NON-METALLIC RARE-EARTH INCLUSIONS IN IRON AND STEEL. Yu. I. Rubenchik, Yu. V. Kryakovskii, V. I. Yavoiskii, and M. N. Kul'kova (Inst. of Steel and Alloys, Moscow). Zavodsk. Lab., 30: 57-8(1964). (In Russian)

Metallographic and x-ray structural methods were used for determining the effect of rare earth inclusion in steel. The results showed that inclusion of 0.5% Ce formed CeO_2. In the presence of sulfur, cerium and lanthanum sulfides were formed. (tr-auth)

14527 SYSTEMS WITH BERYLLIUM OXIDE AND THEIR PRACTICAL APPLICATION. P. P. Budnikov and R. A. Belyaev. Zh. Vses. Khim. Obshchestva im. D. I. Mendeleeva, 6: 629-35(1961).

A review of investigations on systems of beryllium oxide with other oxides is presented. Beryllium oxide is the best matrix for uranium dioxide and thorium dioxide. Porcelain wares containing BeO have outstanding heat resistance properties. Also many different glass types contain BeO, as for instance the well known Lindemann glass, which is especially suited for x rays. BeO-containing glasses can have very different properties, such as a high dispersion factor, a small refraction index, good transparency for ultraviolet rays, and high resistivity to water or chemical agents. Two-, three-, four- and five-component BeO-containing systems are cited with short discussions and corresponding references. (TCO)

14528 STUDIES OF THE RELEASE OF I^{131} FROM NEUTRON IRRADIATED URANIUM DIOXIDE. L. Stieglitz, Thesis, Munich, Technische Universität, 1963. 54p. $2.00 (Gmelin, AEC-DISS. 63-106). (In German)

The I^{131} activity released by UO_2 was collected in KOH and after precipitation measured with a scintillation well counter. A large part of the I^{131} released immediately after heating was absorbed on the surface. Two types of diffusion processes were distinguished. The first is a diffusion through outer UO_2 layers with a small oxygen excess with an activation energy of 30.7 kcal/mole. The second process is a diffusion through the UO_2 lattice with an activation energy of 62.6 kcal/mole. (Gmelin Inst.)

14529 THE PROPERTIES AND APPLICATIONS OF MOLYBDENUM ALLOY STEEL CASTINGS. W. J. Jackson (British Steel Castings Research Assn., Sheffield, Eng.). [1963]. 60p. Available from Climax Molybdenum Co., New York.

Information is included on Mo in steelmaking, Mo in ferritic and austenitic steels; wear-resisting steels; low-temperature steels; heat-resisting and creep-resisting steels; corrosion-resisting steels; weldability; machinability; wear-resisting steel castings; high-strength steel castings; steel castings for use at elevated temperatures; and corrosion-resisting steel castings. 390 references are included. (P.C.H.)

14530 SOME PARAMETERS OF THE MECHANICAL BEHAVIOR OF GRAPHITES. F. J. Digesu and C. D. Pears (Southern Research Inst., Birmingham, Ala.). 51p. (CONF-316-3)

From American Ceramic Society 16th Pacific Coast Regional Meeting, Los Angeles, Oct. 1963.

The strength of graphite was related with the strain rate, surface finish, volume under peak stress, and temperature. The use of gas bearings in the load train to essentially eliminate the eccentric stresses permitted the detection of quite unexpected behaviors that were previously masked by the testing techniques. For example, an increased surface roughness has a deceptively small influence on a graphite compared to more brittle materials such as alumina. At over 3500°F, higher strain rates have a pronounced effect of increasing the strength of graphite from some modes of loading. The moduli are dependent on these parameters and the type of loading, such as compression and tension. Good correlations were found between dynamic and flexural moduli. (P.C.H.)

Radiation Effects

Refer also to abstract 15068.

14531 (AAEC/E-112) THE IRRADIATION BEHAVIOUR OF HOT-PRESSED DISPERSIONS OF $(U,Th)Be_{13}$ IN BERYLLIUM. SECOND IRRADIATION EXPERIMENT. G. L. Hanna, B. S. Hickman, and R. J. Hilditch (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Nov. 1963. 24p.

Fuel specimens with uranium–thorium beryllides as the fissile bearing phase were irradiated at 400 to 700°C to burnups between 7 and 11 at. % uranium in a predominantly thermal flux. Two specimens of massive $(U,Th)Be_{13}$ exhibited good dimensional stability and low fission gas release. Dispersion specimens containing 20, 35, and 50 vol % $(U,Th)Be_{13}$ swelled by 3 to 18% and released up to 33% of the gaseous fission products. The results indicated that the mixed beryllide is an inherently good fuel material and lead to the conclusion that the poor irradiation stability of hot-pressed specimens may not be typical of $(U,Th)Be_{13}$–Be dispersions prepared by other techniques. (auth)

14532 (CEND-190) IRRADIATION TESTING OF CERAMIC FUELS. Summary Report, October 1, 1962–September 30, 1963. G. Zuromsky and W. P. Chernock (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). Sept. 1963. Contract AT(30-1)-2936. 88p.

A program is being carried out to establish the irradiation stability of selected compositions in both the UO_2–CaO–ZrO_2 system and the UO_2–CeO_2 system. Pellets for irradiation testing were prepared by cold pressing and sintering to densities of 89 to 90% of theoretical for the zirconia-base compositions and 92 to 95% of theoretical for the ceria-base compositions. After completion of x-ray diffraction, metallographic, and chemical analyses of selected pellets from each batch, pellets of one composition were assembled into stainless steel cladding tubes. Five clad irradiation samples were assembled into each of 6 capsules. Each capsule contained 3 zirconia-base and 2 ceria-base samples of comparable UO_2 content. Although the corrosion behavior of the selected fuel compositions in 360°C water and 725°C steam was excellent, problems were encountered in sodium for the ceria-base composition. The differences in accrued burnup between the zirconia- and ceria-base samples were estimated as 5 to 10%. Nuclear mockup experiments confirmed the W. B. Lewis method for calculating perturbation factor as a function of burnup for these fuels. Capsules are being irradiated in both the ETR and MTR. (M.C.G.)

14533 (CONF-187-98) EFFECT OF RADIATION ON MECHANICAL PROPERTIES OF CVTR PRESSURE TUBE MATERIALS. W. R. Smalley (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). [1962]. Contract AT(30-1)-2289. 5p.

From American Nuclear Society Meeting, New York, Nov. 1963.

Specimens of annealed Zircaloy-4 were irradiated in low-temperature process water in WTR to equivalent integrated fast neutron fluxes up to 2.5×10^{21} nvt. The radiation effects on the tensile, impact, and creep properties were studied. It is concluded that Zircaloy-4 will be adequate for use in CVTR pressure tubes. (D.L.C.)

14534 (DP-837) IRRADIATION OF URANIUM DIOXIDE FUEL TUBES IN THE VBWR. Henry C. Quigley (Du Pont de Nemours (E. I.) & Co., Wilmington, Del.). Aug. 1963. Contract AT(07-2)-1. 16p.

Two uranium dioxide tubular fuel elements 2 inches in diameter clad with low-iron Zircaloy-4 were irradiated in the Vallecitos Boiling Water Reactor to 3000 Mwd/t average burnup at a peak $\int kd\theta$ rating of 22 watts/cm. The purpose of the irradiation was to determine performance, under conditions approaching those contemplated for heavy water moderated power reactors, of an element made by a combined vibrational compaction and swaging process and one made by vibrational compaction alone. Underwater measurements indicated an increase in inside diameter of the order of 2 mils and an increase in outside diameter of one-half mil or less in each element after the 3000 Mwd/t exposure. The increase in inside diameter is believed to be caused by the excess of coolant pressure over element internal pressure; the increase in outside diameter is believed to be caused by differential thermal expansion of the core and cladding, or possibly stress relief of the cladding. It is concluded that each type of element is capable of undergoing considerably greater burnup without failure. (auth)

14535 (EURAEC-878) RESEARCH TO DETERMINE THE LONG-TERM MECHANICAL PROPERTIES OF METALS SUBJECTED TO MECHANICAL STRESS AT ELEVATED TEMPERATURES AND NEUTRON IRRADIATION. Quarterly Report No. 3. W. Siegfried, A. Bard, and A. Janner (Battelle Memorial Inst. International Div., Geneva). [1963]. Work Performed under United States–Euratom Joint Research and Development Program. Contract 100-62-12 RDS. 23p.

The statistical evaluation of time-to-rupture consists in decomposing the creep process into a thermal activated and a thermal nonactivated part. The thermal activated part is taken to be only a function of the temperature, and the thermal nonactivated part is only a function of the stress. For the time-to-rupture up to 10,000 hr, the logarithm of the time-to-rupture in dependence of the stress and temperature is given by a linear relation. To determine the influence of the formation of a neck (geometrical instability) and the formation of fissures in the grain boundaries on the phenomenological thermodynamic values, calculations on an ideal model of a material are discussed. To determine the connection between the phenomenological thermodynamic values for the formation of rupture and the apparent thermodynamic values for the creep process, tests by the method of Sherby and Dorn will be made. It is shown that the extrapolation methods already developed are valid also under the influence of neutron irradiation. Results show that only interstitials and vacancies are produced by the neutrons. These disturbances produce a climbing of the dislocations. (N.W.R.)

14536 (GEAP-4360) FUEL FAILURE EXAMINATIONS AND ANALYSES IN THE HIGH POWER DENSITY PROGRAM. W. H. Arlt and S. R. Vandenberg (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Sept. 16, 1963. Contract AT(04-3)-361. 95p.

Post-irradiation examinations performed on stainless steel clad UO_2 fuel rod failures are described. The rods were irradiated in the Vallecitos Boiling Water Reactor. Cladding failures occurred in 22 of approximately 700 fuel rods that were irradiated. The failures were cracks, which varied in size from small, barely visible hairline cracks to large cracks in which the UO_2 was exposed to the reactor coolant. In all cases but two, the cracks were longitudinal to the axis of the fuel rod. Metallographic examinations indicated that the cracks are intergranular and start at the outside surface. There was evidence of intergranular corrosion, strongly accelerated by stress. In all cases, the failures occurred in the high heat flux region of the fuel rods. (M.C.G.)

14537 (HW-79766(p.4.1-76)) REACTOR METALS RESEARCH. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Alloy Selection. The procurement and fabrication histories of several alloys are given. The following alloys were irradiated in ETR and the effects of irradiation on the room-temperature mechanical properties evaluated: Nb–1Zr, Nb-752, Inconel 625, Inconel 718, Hastelloy N, Hastelloy R-235, Hastelloy X, and TD Nickel. In-Reactor Measurements of Mechanical Properties. The Arrhenius plot of the in-reactor creep rate of Zircaloy-2 is given, and a correlation is drawn with the theta parameter. Progress is reported on in-reactor creep testing of 304 stainless steel. Irradiations Effects. The operating history of ETR and G-7 loop is given. The status of computer programs (REM, TEND, BEND) is described briefly. Results are tabulated for tensile tests of irradiated and unirradiated Zircaloy-2 specimens from NPR tubing and of irradiated stainless steels. Studies were made of preconditioning treatments of Hastelloy X-280 and of the fracture properties of irradiated AISI 348 stainless steel. Damage Mechanisms. Rate theory was applied to the process of plastic deformation to derive a theory of radiation damage, and experimental studies were made on iron and copper. (D.L.C.)

14538 (ORNL-3523(p.69-100)) IRRADIATION TESTING OF COMPONENTS AND MATERIALS. D. B. Trauger and O. Sisman (Oak Ridge National Lab., Tenn.).

A capsule containing an EGCR prototype-diameter UO_2 specimen was discharged from the ETR following evidence of cladding rupture. A summary of the status of the ETR irradiations is presented. There are 10 capsules being irradiated. Six instrumented fuel elements irradiated in GCR-ORR loop No. 1 were examined. Four of the elements had wire spirally wrapped and brazed on the outer surface of the cladding, and the outer surfaces of the other two were smooth. The two wire-wrapped elements, operated at a maximum heat rate of 44,000 Btu/hr · ft and a cladding temperature of approximately 1500°F, did not fail during seven weeks of irradiation. The wire-wrapped element operated at 69,000 Btu/hr · ft and a cladding temperature of approximately 1500°F indicated a cladding failure after three weeks. The fourth wire-wrapped element failed during start-up of the reactor. One of the smooth-surface elements failed during 14 weeks of operation at a heat rate of 23,000 Btu/hr · ft and a cladding temperature of approximately 1500°F. The other smooth-surface element was in good condition following operation for seven weeks at a heat rate of 44,000 Btu/hr and a cladding temperature of 1550°F. Four capsules containing EGCR production-run fuel pellets and cladding were examined after irradiation in the ORR to burnups ranging from 560 to 2800 Mwd/MT of UO_2. The average cladding temperatures ranged from 1415 to 1480°F. None of these capsules failed, but porosity was observed in the cladding of one capsule at pellet-to-pellet interfaces. This capsule was thermally cycled at a rate greater than 150°F/min, whereas the others were thermally cycled at lower rates. An ETR-irradiated capsule consisting of stainless steel-clad hollow UO_2 pellets that failed during operation was examined. This capsule was in the ETR for 38 months at an average cladding temperature of approximately 1500°F and a maximum power level of 127% of the design level. The burnup reached 9100 Mwd/MT of UO_2. The failure was in the form of a circumferential crack. Microscopic examination of this area revealed extensive nitriding of the stainless steel cladding. Similar results were obtained for other ETR-irradiated capsules. The in-pile fission-gas release characteristics of the first UO_2 single-crystal specimen are confirmed. The release rate was found to decrease with burnup, and the temperature-dependent release rate was essentially independent of fission rate. Postirradiation electron micrographs indicated surface smoothing. The activation energies of the specimens were 60 and 25 kcal/mole. No change in activation energy was observed between 700 and 1300°C for Kr^{88} release. Mechanisms are suggested for the low-temperature (less than 100°C) in-pile release of fission gases from UO_2. Equations relating the number of fission recoil tracks cutting the open surface of a sample and its BET surface area were developed. (auth)

14539 (RADC-TDR-63-226) ANALYSIS OF FAILURE MECHANISMS WITH HIGH-ENERGY RADIATION. Final Report. R. L. Anthony, V. R. Honnold, and C. B. Schoch (Hughes Aircraft Co., Fullerton, Calif.). May 1, 1963. Contract AF30(602)-2596. 95p. (AD-412647)

The effects of cobalt-60 gamma radiation on good and

failed silicon and germanium diodes, and on silicon PNP transistors, were investigated in some detail for accumulated doses up to 5×10^7 r. For the diodes, much greater changes in reverse current were produced in the failed units than in the good units by the irradiation. The results for the silicon PNP transistors were not as definite. Preliminary studies of the effects of varying the gas ambient upon the I–V characteristics of germanium diodes were made with the aid of a dry-type high vacuum system especially constructed for use on this contract. Reverse characteristics of good units were much more stable than those of failed units for ambient variations from dry air at 1 atmosphere to vacua of 2×10^{-9} Torr. A preliminary study was made of failure mechanisms in Teflon arising from thermal embrittlement. Cobalt-60 gamma radiation was used to accelerate the embrittlement process. The degree of crystallinity, believed to correlate with the embrittlement, was measured by x-ray diffraction and by hydrostatic weighing as a function of radiation dosage. (auth)

14540 (RAE-TM-SPACE-19) EFFECTS OF GAMMA RADIATION ON FLUOROLUBE. M. J. Downey (Gt. Brit. Royal Aircraft Establishment, Farnborough, Hants, England). July 1963. 7p. (N63-22213)

A preliminary radiation effects study was conducted on Fluorolube 230 to evaluate its usefulness as a damping fluid in a satellite gyroscope. Particular attention was paid to viscosity and acidity, and radiation doses ranged from 4 to 500 Mrad. The results show that viscosity decreases with irradiation by less than 10% at 50 Mrad. The acidity tended to increase with irradiation, but the amount of increase depended on the type of container used (100 ppm HF in borosilicate glass, 40 ppm HF in silica glass at 50 Mrad). (D.L.C.)

14541 (TID-7676(p.38-62)) RESEARCH ON URANIUM CARBIDES [AT] BATTELLE MEMORIAL INSTITUTE. W. Chubb and R. F. Dickerson (Battelle Memorial Inst., Columbus, Ohio).

Studies of uranium carbides as low-cost fuel for power reactors are discussed. The factors that influence the composition of skull-melted UC castings were investigated. Evaluations of various graphites, segregation in the skull, and effects of atmosphere are discussed. The hot hardness of U–C systems containing 5, 7, and 9 wt % was measured at 1000 to 1500°C. Constitutional diagrams were determined. The thermal expansion properties of uranium carbides were measured, along with electric conductivity. Irradiation damage was investigated for 36 specimens. Results are presented in tables, graphs, and photographs. (M.C.G.)

14542 (TID-7676(p.170-82)) POST IRRADIATION EXAMINATION OF STAINLESS STEEL CLAD UC, UC–UFe_2 AND PuC–UC FUEL PELLETS. B. T. Bradbury, J. E. Cole, B. R. T. Frost, and J. D. B. Lambert (United Kingdom Atomic Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England).

Nine miniature fuel elements comprised of stainless steel clad carbide fuel pellets were irradiated in a vertical hole in PLUTO to determine their irradiation performance at fairly modest temperatures and burnups. Fission gas release values were very low, and in most cases were of the same order as, or much less than, calculated release values based on a surface recoil mechanism. With the exception of irregular patterns of microcracking, the microstructures of all the carbides were unchanged during irradiation. Fuel-sheath compatibility was good. (M.C.G.)

14543 (TID-20237) INVESTIGATIONS OF RADIATION EFFECTS IN METAL OXIDES AND AZIDES BY ELECTRON SPIN RESONANCE. Progress Report, February 1, 1963–January 31, 1964. Ralph H. Bartram and Otis R. Gilliam (Connecticut. Univ., Storrs). Feb. 10, 1964. Contract AT(30-1)-2047. 87p.

Radioinduced defects in single crystals of metal oxides and metal azides are being investigated by electron-spin resonance. The radiation is supplied by an electron accelerator, the Brookhaven Research Reactor, Co^{60} gamma-ray sources, and ultraviolet lamps. The major objectives are the identification of radioinduced defects, a study of their growth and stability, and the correlation of these defects with changes in the properties of the irradiated solids. The ESR spectra of gamma-irradiated Al_2O_3 are attributed to F centers and to holes trapped at charge-deficient cation sites. Reactor-irradiated Al_2O_3 has two prominent ESR spectra; one of these is attributed to $(AlO)^{3-}$ molecules formed by replacement collisions, and the other remains unidentified but appears to be a superposition of many spectra. Reactor plus low-temperature gamma irradiation yields a spectrum attributed to interstitial O^+. Electron irradiation of Al_2O_3 is in progress. The new spectra are not identified, but it is established that the threshold energy for oxygen displacements by electron bombardment is below 1 Mev. A number of possible defects in Al_2O_3 are investigated theoretically. It is concluded from this investigation that interstitial O^0 should have no ESR spectrum at 3-cm wavelength, that interstitial O^+ should have no optical spectrum, and that the defects at cation sites which trap holes are vacancies rather than impurities. In addition, a 7.4-ev optical band is associated with F centers, a 3.08-ev band with trapped holes, and a 2.00-ev band with interstitial O^0. It is proposed that measurements be made with improved resolution, using K-band ESR and ENDOR techniques. Measurements on the growth, annealing, and threshold energy for production of electron-induced defects in Al_2O_3 will continue, and the identification of centers responsible for new ESR spectra will be attempted. Theoretical calculations will be refined and extended to more centers including those induced by electron irradiation. Some effort will be devoted to other materials besides Al_2O_3. (auth)

14544 (USAELRDL-TR-2306) PULSED NUCLEAR RADIATION EFFECTS ON ELECTRONIC PARTS AND MATERIALS. (SPRF NO. 1). W. Schlosser, C. P. Lascaro, and J. Key (Army Electronics Research and Development Lab., Fort Monmouth, N. J.). Sept. 1962. 45p. (AD-412556)

The results of a recent series of experiments conducted on electronic parts at the Sandia Pulsed Reactor Facility are discussed. Cables, resistors, and ferrite cores were included in the program. Four cables including RG-62A/U, RG-59B/U, RG-81/U, and a twisted pair line cord were exposed in various geometries, circuits, and applied voltages. Exposed also were 100-ohm, 1-kohm, 10-kohm, and 100-kohm carbon film resistors, a 100-ohm wire wound resistor, as well as manganese–zinc and nickel–zinc ferrite cores. Peak induced currents observed in cables were: +3000 to −2650 microamp in looped RG-81/U, +600 to −2500 microamp in looped RG-62A/U, +300 to −380 microamp in looped RG-59B/U, +400 to −1650 microamp in looped twisted pair, +80 to −90 microamp in straight potted RG-62A/U, and +800 to −500 microamp in straight unpotted RG-62A/U cable. Low-value resistors appeared quite stable, but resistors greater in value than 10 kohm showed a spurious and inconsistent behavior, attributed largely to lead cable efforts. The measurements on cables and resis-

tors seem to bear out the fact that reliable data cannot yet be obtained for many exposed component parts because of the unpredictable behavior of the cables used for signal transmission. (auth)

14545 (EURAEC-863) INVESTIGATION INTO THE INFLUENCE OF NEUTRON IRRADIATION ON THE PROPERTIES OF THE ALLOY $ZrNb_3Sn_1$. Quarterly Report No. 5, July 1–September 30, 1963. (Metallgesellschaft A. G., Frankfurt am Main). Oct. 25, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 092-62-7 RDD. 32p. (A translation)

The irradiation of the samples in the reactor, on which the influence of neutron irradiation on mechanical properties was to be tested, was completed and preparations for testing were begun. The tests on corrosion under irradiation were begun, the instruments for the tests were set up, and the autoclave containers were prepared. The testing of the nonirradiated samples has shown that long-duration annealings at 300°C lower the values of the notch impact tenacity of the alloys $ZrNb_3Sn_1$ and Zircaloy-2. The tests on corrosion without irradiation were continued and the anisotropy of the samples intended for irradiation was followed by means of hardness tests. (auth)

14546 DIRECT OBSERVATION OF DISAPPEARANCE AND COLLAPSE OF STACKING-FAULT TETRAHEDRA IN GOLD FOILS DURING ION BOMBARDMENT IN THE ELECTRON MICROSCOPE. L. M. Howe and J. F. McGurn (Atomic Energy of Canada Ltd., Chalk River, Ont.). Appl. Phys. Letters, 4: 99-102(Mar. 15, 1964).

To obtain information on the mechanism of collapse of stacking-fault tetrahedra produced during quenching and subsequent aging of gold, foils were bombarded with 100-kev oxygen ions in an electron microscope. Bombardment resulted in the appearance of defects in the form of spots and in the disappearance of the tetrahedra. The results indicate that the long-range migration of interstitial atoms does not play a significant role in the collapse of the tetrahedra. (C.E.S.)

14547 EFFECT OF THE DOSE RATE ON THE ^{60}Co γ-RADIATION INDUCED CHANGES IN THE FERROELECTRIC PROPERTIES OF TRIGLYCINE SULPHATE. B. Hilczer and J. Jaskulski (Inst. of Physics, Polish Academy of Sciences, Poznan and Mickiewicz Univ., Poznan, Poland). Bull. Acad. Polon. Sci., Ser. Sci. Math., Astron. Phys., 11: 715-17(1963).

The effects of dose and dose rate in the gamma irradiation of triglycine sulfate are discussed in terms of hysteresis characteristics, dielectric permittivity, and Curie point temperature shift. (R.E.U.)

14548 MAGNETIC ORDERING OF DIFFUSION IN PURE NICKEL IRRADIATED WITH NEUTRONS AT 28°K. Pierre Peretto, Pierre Moser, and Daniel Dautreppe (CEN, Grenoble, France). Compt. Rend., 258: 499-501(Jan. 13, 1964). (In French)

After neutron irradiation at 28°K, nickel displayed several bands of magnetic ordering due to different defects. The recovery and reorientation energies of the defects were determined. (tr-auth)

14549 THE RESISTIVITY OF PURE AND DOPED IRON IRRADIATED WITH FAST NEUTRONS AT 78°K. Colette Minier-Cassayre (CEN, Grenoble, France). Compt. Rend., 258: 541-4(Jan. 13, 1964). (In French)

Investigation of the resistivity of pure iron irradiated at 78°K to various integrated doses reveals a variation of the relative concentration of the different defects created. The effect of introducing impurity atoms permits identification of several types of interaction between the impurities and the defects created by irradiation. (tr-auth)

14550 RADIATION DAMAGE TO GLASS SURFACES BY α-PARTICLE BOMBARDMENT. D. G. Tuck (Univ. of Nottingham, Eng.). Intern. J. Appl. Radiation Isotopes, 15: 49-57(Feb. 1964).

The bombardment of glass surfaces with α particles from Po^{210}, Rn^{222}, Ra^{226}, Pu^{239}, and Cm^{242} causes surface changes both in the presence and absence of an aqueous phase. The changes are discussed, as are the properties of the siliceous deposit sometimes produced by highly α-active solutions. The different theoretical treatments are compared. Attention is drawn to the importance of these effects in radiochemical work. (auth)

14551 RADIATION-INDUCED STRESS RELAXATION IN QUARTZ AND VITREOUS SILICA. W. Primak (Argonne National Lab., Ill.). J. Appl. Phys., 35: 1342-7(Apr. 1964).

Helium or proton beams, penetrating several microns or more, cause crazing on vitreous silica surfaces. In a lower energy range (beams up to 150 kev were used) there was observed upon irradiation a plastic flow stress relaxation that relieved the stress from the radiation-induced dilatation and resulted in the total volume change in vitreous silica or quartz occurring perpendicular to the surface. Implications of this radiation-induced stress relaxation seem fundamental to the radiation behavior of quartz, silica, and similar substances, and are discussed. (auth)

14552 EFFECT OF Co-60 GAMMA IRRADIATION ON SURFACE ENERGY OF KCl. T. K. Bhattacharya, H. Nonenmacher, and L. I. Grossweiner (Illinois Inst. of Tech., Chicago). J. Appl. Phys., 35: 1352-3(Apr. 1964).

The {100} surface energy of KCl was measured after Co-60 gamma irradiation at 25°C and after subsequent optical and thermal treatment. The fracture energy was determined by a slow cleavage method, and the external surface energy was measured with a pendulum sclerometer. (R.E.U.)

14553 FISSION-GAS RELEASE FROM PYROLYTIC-CARBON-COATED FUEL PARTICLES DURING IRRADIATION. P. E. Reagan, F. L. Carlsen, and R. M. Carroll (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 18: 301-18(Mar. 1964).

Fission-gas release from pyrolytic-carbon-coated uranium carbide particles was studied as part of a fuel development program for gas-cooled reactors. The particles were contained in a test capsule between concentric cylinders of porous graphite and were heated by fission heat. A small flow of helium was used to sweep the fission gas from the test capsule. Uranium carbide particles coated with three types of pyrolytic carbon (laminar, columnar, and duplex), as well as uncoated uranium carbide particles, were irradiated at temperatures up to 1800°F. The steady-state fission-gas release rates were measured as a function of temperature and burnup. All three coating types greatly reduced the fission-gas release rate from uranium carbide particles; the duplex coating was much better than the laminar or the columnar coatings. Post-irradiation examination revealed less than 0.1% broken coatings for the duplex coating. A radiation-induced reaction zone was observed at the fuel/coating interface for all three types. A correlation was made between the number of broken coatings and fission-gas release rate. (auth)

14554 DECOMPOSITION OF DEFECTS BY NEUTRONS IN REIRRADIATED GRAPHITE. Donald G. Schweitzer, Robert M. Singer, Seymour Aronson, Jerome Sadofsky,

and David H. Gurinsky (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 18: 406-8(Mar. 1964). (BNL-7104)

Separation of effects of thermal annealing and radiation enhancement of defect annealing in the reirradiation of AGOT graphite at 350°C after neutron irradiation at 30°C is accomplished. The reirradiations are seen to involve competitive reactions between production and decomposition of interstitial complexes. (R.E.U.)

14555 EFFECT OF THE GAMMA IRRADIATION ON THE ELECTRON WORK FUNCTION OF PLATINUM IN THE PRESENCE OF OXYGEN. Juliusz Siejka (Inst. of Nuclear Research, Warsaw). Nukleonika, 8: 635-8(1963).

The influence of gamma irradiation on the electron work function of platinum plate was investigated as a function of oxygen pressure. On the other hand the influence of e.w.f. value of investigated samples before irradiation was examined on the effect observed after irradiation at the same oxygen pressure. It was found that irradiation caused changes of e.w.f. values but the magnitude of observed effects and/or their signs depend on the oxygen pressure and on the e.w.f. values of investigated samples before the irradiation. (auth)

14556 ON THE RADIOINDUCED PHASE TRANSFORMATIONS OF $BaTiO_3$. M. Schenk. Phys. Status Solidi, 4: K25-8(1964). (In German)

Lattice constant changes in $BaTiO_3$ after reactor irradiation and accelerator irradiation were determined. At a dose of about 4.2×10^{18} n_f/cm^2 a phase transformation from the tetragonal to the cubic phases occurred. The results were compared with defect numbers using the cascade theory. (M.C.G.)

14557 ELECTRON MICROSCOPIC CONTRAST EXPERIMENTS ON DEFECT AGGLOMERATION IN NEUTRON IRRADIATED COPPER. U. Essmann and M. Wilkens (Max-Planck-Institut für Metallforschung, Stuttgart and Technische Hochschule, Stuttgart). Phys. Status Solidi, 4: K53-5(1964). (In German)

A "dark point" lattice defect in irradiated copper was investigated. The copper samples were irradiated at about 80°C with 2×10^{17} to 2×10^{18} fast neutrons/cm^2 and investigated with an electron microscope. A black-white contrast with dimensions of 20 to 200 Å was observed. Symmetry of the black-white contrast was found. (M.C.G.)

14558 SMALL-ANGLE SCATTERING ON NEUTRON-IRRADIATED COPPER. W. Schilling and W. Schmatz (Technische Hochschule, Munich). Phys. Status Solidi, 4: 95-101(1964). (In German)

Small-angle scattering of subthermal neutrons ($\lambda \approx 9$ Å) was measured on polycrystalline, pile-irradiated copper. The scattering was due to regions of high vacancy densities and disappeared after thermal treatment at 570°C. The angular dependence could not be measured because of the low scattering intensity. The measured integral intensity could be compared with the electron-microscopic results of Makin. The dislocation loops observed electron-microscopically could not account for the observed integral scattering intensity. The results of this scattering experiment can be due to either spherical regions of high vacancy densities or alternatively dislocation loops. It was assumed that one primary recoil atom produces one of these vacancy agglomerates. For the first model the number of vacancies, calculated from the measured intensity, was found to be of the order of 20 vacancies per zone. About 40 vacancies would be arranged in a dislocation loop of a diameter of 15 Å in the second model. (auth)

14559 HARDENING BEHAVIOR OF NEUTRON-IRRADIATED METALS. I. FERROMAGNETIC INVESTIGATIONS OF NICKEL SINGLE CRYSTALS. H. Rieger, A. Seeger, and H. Kronmueller (Max-Planck-Institut für Metallforschung, Stuttgart and Technische Hochschule, Stuttgart). Phys. Status Solidi, 4: 163-76(1964). (In German)

Variations of the initial and final susceptibility and the coercive field due to tensile plastic deformation were measured for neutron-irradiated (with a flux of 0.8×10^{18} neutrons/cm^2) and non-irradiated Ni single crystals. A comparison was made of the deformation dependence of the magnetic quantities in these two cases. In irradiated crystals the density of the operating dislocation sources was higher and the dislocation slip distance shorter than in non-irradiated crystals. The τ_S-contribution to the flow stress was larger at the beginning of the deformation in the irradiated crystals; it decreased with increasing deformation. The additional τ_S-contribution in irradiated crystals was attributed to the dislocations cutting through the diluted crystal zones produced by the irradiation, in agreement with other investigations. The decrease of the τ_S-contribution with increasing slip was accounted for by the destruction of these zones by the cutting process. This destruction of the zones accounted also for the reduction, with increasing deformation, of the differences in the deformation behavior of non-irradiated and neutron-irradiated Ni single crystals. (auth)

14560 HARDENING BEHAVIOR OF NEUTRON-IRRADIATED METALS. II. TEMPERATURE VARIATION TESTS AND SLIP-LINE OBSERVATIONS ON COPPER SINGLE CRYSTALS. U. Essmann and A. Seeger (Max-Planck-Institut fur Metallforschung, Stuttgart and Technische Hochschule, Stuttgart). Phys. Status Solidi, 4: 177-97(1964). (In German)

Deformation experiments are performed, at 4.2 and 78°K, on neutron-irradiated copper single crystals (neutron flux 2×10^{17} and 1×10^{20} neutrons/cm^2). The slip-line pattern was investigated by electron microscopy. The temperature dependent fraction of the yield stress was investigated, during deformation, over the temperature ranges 4.2 to 78 and 78 to 293°K. By comparing the slip band structures corresponding to different deformation intervals an explanation was obtained for the yield phenomenon occurring during re-loading and deformation softening. This explanation is based on the observation of a reduction of radiation damage in the deformed crystal region. The special conditions during deformation in very strongly irradiated crystals are discussed and related to the inhomogeneity of the deformation process. (auth)

14561 THE INFLUENCE OF THE INITIAL DEFECT CONCENTRATION ON THE ANNEALING OF LOW-TEMPERATURE IRRADIATED METALS. G. Burger, H. Meissner, and W. Schilling (Technische Hochschule, Munich). Phys. Status Solidi, 4: 267-79(1964).

Measurements were made of isochronal annealing in aluminum, copper, silver, and gold, after irradiation at 4.5°K with various doses of fast neutrons. It is shown that the relative amount of recovery within annealing stage I is reduced, and annealing stage III is shifted to lower temperatures with increasing defect concentration. The first observation can be explained by the higher probability for annihilation of close Frenkel-pairs, during the radiation-annealing process, compared with the probability for recombination of more distant Frenkel-pairs. The shift with concentration of annealing stage III and annealing stage I_E

for aluminum indicated the existence of freely-migrating defects. For aluminum the existence of two freely-moving interstitials was confirmed. In addition it is shown that the observed annealing behavior of all the metals considered can be explained by this two-interstitial model (previously proposed by Seeger and Sosin) taking into account the different defect arrangements produced by low-temperature electron and neutron irradiation. (auth)

14562 ANALYSIS OF RADIATION ANNEALING OBSERVED DURING LOW TEMPERATURE IRRADIATION WITH NEUTRONS AND HEAVY CHARGED PARTICLES. G. Burger, H. Meissner, and W. Schilling (Technische Hochschule, Munich). Phys. Status Solidi, 4: 281-8(1964).

Large radiation annealing effects were observed for different metals during reactor irradiation at 4.5°K. Saturation values for the resistivity changes were obtained by extrapolation from the linear decrease of the effective damage rate with defect concentration. These results agreed well with those deduced from radiation annealing observed during irradiation with alpha particles. Various physical processes, which were thought to contribute to the observed reduction of the accumulation rate of defects with irradiation time, were analyzed. (auth)

14563 EFFECTS OF RADIATION ON ALLOYS. Arthur Damask (Brookhaven National Lab., Upton, N. Y.). Proc. Symp. High Power Accelerator Appl., New York, 1961, 31-42(1962).

In a large class of metals and alloys, the interchange of atoms takes place via the vacancy method. The rate of atomic interchange of atoms is, therefore, proportional to the number of vacancies present. The equilibrium number of vacancies in a solid increases exponentially with increasing temperature, and hence also the atomic diffusion rate. At low temperatures, because of the low number of vacancies, an alloy cannot achieve its equilibrium or lowest free-energy state, within human lifetime. One of the effects of bombardment of solids by nuclear particles is to displace atoms from their position which leave behind vacant lattice sites, and these excess vacancies make the same contribution to atomic diffusion as the thermal vacancies. High-energy particles of large mass, such as neutrons, cause the displacement of a large number of atoms in a local region. In an alloy with a specified atomic arrangement, this local damage can break up precipitate particles, disorder an ordered arrangement, or serve as a nucleation site for precipitation. The vacancies created can also cause enhanced diffusion. Bombardment by high-energy particles of light mass such as electrons displaces only one or two atoms per incident particle, so that the enhanced diffusion effect of the vacancies can be isolated and used as a laboratory tool without the deleterious effects of heavy particle damage. Thus, by the controlled production of excess vacancies by irradiation, it is possible to make an alloy achieve its lowest free-energy state at temperatures where this was heretofore impossible. The theory and experiments of the past few years related to the understanding of this process and the developing of it to a stage of practical usefulness in the laboratory are reviewed. An example of the agreement of theory and experiment is shown in which α-brass that was brought to its equilibrium state by thermal means alone is shown to be 30,000 years. The generalized theory of enhanced diffusion with the relation of the temperature dependence to the mechanism of defect annealing and the comparison with experiment is shown. Some applications such as low-temperature diffusion and phase boundary determination are discussed. (auth)

14564 RADIATION EFFECTS ON SEMICONDUCTORS. G. K. Wertheim (Bell Telephone Labs., Inc.). Proc. Symp. High Power Accelerator Appl., New York, 1961, 43-58 (1962).

Bombardment of solids with energetic charged particles produces both ionization and displaced atoms, but most of the energy of the incident particle is transferred to the electrons of the solid. In a semiconductor, this ionization is rapidly converted into conduction-band electrons and valence-band holes. These, in turn, disappear through well-known recombination processes in a matter of microseconds. The displacement of atoms results in empty lattice sites, so-called vacancies, in addition to the interstitial atoms. These two types of primary defect then generally undergo complicated rearrangements by diffusion to produce configurations stable at room temperature. Semiconductors are, in many respects, advantageous systems in which to study the properties of such lattice imperfections because concentrations as low as one defect for 10^{10} lattice atoms can be detected by electrical measurements. On the other hand, chemical impurities and dislocations that may be present in similar concentrations may critically affect the nature of the damage configuration. For example, it was shown that the vacancy in silicon is mobile at room temperature and pairs with oxygen, a common impurity. Impurity dependent effects were also observed in germanium. The majority of work reported to date was concerned primarily with the behavior of the bulk properties of semiconductors under room temperature bombardment. While such studies give little information about the microscopic nature of the defects, they are of immediate practical significance since they bear on the operation of semiconductor devices in a radiation field and after irradiation. (auth)

14565 IRRADIATION EFFECTS IN METALS. E. Schmid and K. Lintner. Radex Rundschau, No. 4, 519-34(1963). (In German)

A theoretical review of the effect of irradiation on the crystal lattice of metals and means of direct and indirect investigation of irradiation effects by field ion microscopy, electron microscopy, low-angle X-ray scattering, and measurement of the Hall effect and electrical resistance modulus of elasticity and internal friction as affected by irradiation is presented. Examples are given for Zr, Al, Cu, MnSi steel, CrNi 189 steel, Pb alloys, and semiconductors such as Ge and graphite. (Rev. Metal Lit., 21: No. 1, Jan. 1964)

14566 THE DISTRIBUTION FUNCTION OF THE INTERSTITIALS AND VACANCIES IN A CASCADE OF DISPLACEMENTS PRODUCED BY IRRADIATION. A. Corciovei, A. Babcenco, and D. Grecu (Inst. of Atomic Physics, Bucharest). Rev. Phys., Acad. Rep. Populaire Roumaine, 8: 445-60(1963). (In French)

Previous calculations on the distribution function of the displaced atoms (interstitials) are continued, and a method for approximate calculation of the distribution function of the vacancies is outlined. (tr-auth)

14567 RADIATION DEFECTS CREATED IN GERMANIUM BY FAST 28-Mev ELECTRONS. B. M. Konovalenko, S. M. Ryvkin, and I. D. Yaroshetskii (Ioffe Inst. of Physics and Tech., Leningrad). Soviet Phys.-Solid State (English Transl.), 5: 1513-20(Feb. 1964).

The energy spectrum and the rate of creation of effective acceptor levels of radiation defects were determined in a series of germanium samples with different initial concentrations of donors ($4 \times 10^{13} - 4 \times 10^{17}$ cm^{-3}) bombarded with 28-Mev electrons. Using the concept of mono-

and bipolar annealing of defects, an attempt is made to explain the decrease in the rate of formation of defects, the dependence of the number of these defects on the initial concentration of donors, and the difference in the behavior of germanium under the effect of different types of radiation. (auth)

14568 DIELECTRIC PROPERTIES OF KBr SINGLE CRYSTALS IRRADIATED WITH FAST ELECTRONS. V. V. Krasnopevtsev (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Solid State (English Transl.), 5: 1645-50(Feb. 1964).

A study was made of the dielectric properties and optical absorption of KBr single crystals subjected to bombardment with electrons of 0.5, 0.75 and 1.0 Mev energies. The electron bombardment produced F and V_2 centers and defects in the KBr lattice, causing dielectric relaxation which was described satisfactorily by the Cole-Cole diagram. The mechanism of radiation defect formation and annealing is discussed. (auth)

14569 THE INFLUENCE OF NEUTRON IRRADIATION ON THE DECAY OF METALLIC SOLID SOLUTIONS. G. I. Natsvlishvili and V. S. Chikobava. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 9: 159-69(1963). (In Russian)

Microstructures of specimens of solid solutions Al–Cu (2% Cu by weight), Al–Cu (4% Cu by weight), Cu–Be (2.5% Be by weight) irradiated and not irradiated by neutrons (the integral flux 2×10^{19} n/cm^2) were investigated by the electronic microscopic method. The microhardness of these solid solutions was measured before and after irradiation. There was not observed any significant effect of the irradiation of Al–Cu specimens. In the case of Cu–Be specimens dispersion particles of γ-secondary phase are generated in the α-solid mother liquor after the irradiation. Microhardness as a result of irradiation increased in the α-solid solution from 148 ± 6 to 490 ± 35; and in γ-phase it increased from 530 ± 35 to 870 ± 60. The increase of microhardness of α-solid solution more than three times is caused, in the main, by its decay under the action of neutron irradiation and by formation of dispersion particles of γ-secondary phase. The increase of microhardness of γ-primary phase is, in the main, caused by radiation damages. (auth)

14570 INCREASE OF THE THERMAL STABILITY OF POLYETHYLENE-INSULATED LINES BY IONIZING RADIATION. V. L. Karpov, Yu. M. Malinskii, L. V. Mitrofanova, S. T. Slinitsyn, E. E. Finkel, A. S. Fridman, and S. M. Chernetsov. Tr. Tashkentsk. Konf. po Mirnomu Ispol. At. Energii, Akad. Nauk Uz. SSR 1(1959), 383-9(1961).

A copper wire 1 mm in diameter and insulated with 0.5 mm of polyethylene was irradiated by a Co^{60} gamma radiation source of 20000 g-equ Ra in a vacuum as well as by an electron linear accelerator in the air. The thermal stability of the irradiated samples was determined by the analysis of the thermomechanical curves. The deformation that was attained is a measure of thermal stability at given temperature and load. The lifetime of the workpiece can be estimated from the time dependence of deformation at constant temperature and load. At increased temperatures the deformation is lower, the higher the radiation dose, and remains practically constant up to 250°C. The restriction of deformation under a load of 0.5 kg to about half the radial thickness by irradiation with doses of 100-150 Mrad or by irradiation with 1-Mev (15 μa/cm^2) electrons for 2-4 min guarantees the usability of lines above 80°C. The final deformation is increased by a load increase without any change of its nature. The line still remains efficient if the load is quadrupled. The deformation is only little temperature-dependent under both long and brief load action. A line with irradiated insulation can be exposed to 180°C for at least 4 hrs, and remains efficient for some hours even at 230-250°C. Gamma irradiation in vacuo increases the stability at 20 and 90°C, while doses of more than 200 Mrad reduce it. The irradiation of 0.4 mm thick samples in the air reduces the relative elongation and also the tensile strength at 20 and 90°C. The best strength properties are achieved by irradiation in vacuo with doses of up to 100 Mrad. Tensile strength, resistance to frost, electric breakdown and electrical resistance of a sample irradiated with a gamma dose of 100 Mrad or, equivalently, with 1-Mv electrons for 2-4 min were fully satisfactory. The resistance of line insulation to thermal aging drops with increasing radiation dose. Samples irradiated with electrons are more resistant in this respect than samples irradiated with an equivalent gamma dose. (TCO)

14571 THE RELAXATION OF THE INITIAL SUSCEPTIBILITY AND ITS RECOVERY IN NICKEL, INVESTIGATED USING POLYCRYSTALLINE SPECIMENS AFTER DEFORMATION, QUENCHING AND NEUTRON IRRADIATION. Hans Jaeger (Max-Planck-Institut für Metallforschung, Stuttgart and Technische Hochschule, Stuttgart). Z. Metallk., 55: 17-29(Jan. 1964). (In German)

The recovery of nickel after plastic deformation, neutron irradiation, and quenching was investigated by measuring the initial susceptibility and, on quenched samples, the coercive force. The following stages of recovery were observed: a stage near 0°C in deformed nickel in accordance with previous investigations, probably due to the separation of vacancy pairs from impurity atoms with an activation energy of 0.82 ev; a stage (III) near 100°C in deformed and in irradiated nickel, in accordance with previous investigations, probably due to the annihilation of interstitial atoms with an activation energy of (1.02 ± 0.03) ev; stage IV in deformed nickel, the annihilation of vacancies with an activation energy of (1.6 ± 0.1) ev; between these stages, in deformed and irradiated nickel, some more or less continuous recovery, probably due to the annihilation of vacancies coupled to solute atoms; a stage near 100°C, in quenched nickel, possibly explained by the separation of vacancy pairs from either vacancy clusters or from impurity atoms with an activation energy of (1.26 ± 0.03) ev; and at 180 ± 30°C in irradiated nickel, annihilation of some particular lattice defect, which gives rise to strongly temperature dependent relaxation near −15°C. Possibly this defect is an interstitial pair of an impurity atom and a nickel atom. Its activation energy is (0.82 ± 0.08) ev. (auth)

14572 STIMULATION OF DIFFUSION IN METAL SURFACES BY RADIATION. R. Sizemann. Thesis, Munich, Technische Universität, 1963. 46p. $2.00(Gmelin, AED-DISS. 63-110). (In German)

Kinetic differential equations for the time-space distribution of Frenkel defect density in an irradiated solid are given. Numerical values of the coefficients of this equation for Cu were determined. The stationary solution of this equation indicates that the smoothing of an irradiated Cu surface is not due to a diffusion of atoms from the volume to the surface. The efficiency of this process is too small. The smoothing of irradiated surfaces is due to surface tension effects. Calculations are in agreement with experimental results. (Gmelin Inst.)

14573 METHOD OF AND APPARATUS FOR IRRADIATING FLUID AND SOLID MATERIALS WITH EMANATIONS FROM A RADIOACTIVE SOURCE. Hugh M. Barton, Jr. (to Phillips Petroleum Co.). U. S. Patent 3,124,687. Mar. 10, 1964. Filed May 19, 1954.

A method is described for irradiating materials by lowering or flowing into a curved bore hole. (R.E.U.)

METEOROLOGY

14574 (ANL-6769(p.181-96)) A NOTE ON ELLIPSOIDAL WIND DISTRIBUTIONS. Harold L. Crutcher and Harry Moses (Argonne National Lab., Ill.).

The concept of wind distributions was extended from two to three dimensions. Homogeneous random wind observations may be described by the trivariate normal distribution. A multivariate normal distribution is distributed as chi square with degrees of freedom equal to the number of variates. The probability density function of the trivariate normal distribution can be written as $f(x_1, x_2, x) = C \exp -(\frac{1}{2}) x \sigma^{ij} x'$, where σ^{ij} is the inverse of the positive definite covariance matrix, σ_{ij}, x' is the transpose of the x matrix and $C = |\sigma^{ij}|^{\frac{1}{2}}(2\pi)^{-\frac{1}{2}}$. In the isotropic case, the distribution will be spherical. In all other cases, except the limiting straight-line form, the distribution will be ellipsoidal with magnitude and direction of the semi-axes determined respectively from the eigenvalues and eigenvectors of the covariance matrix. Tests for sphericity or isotropy are shown and application to diffusion problems indicated. (auth)

14575 (ANL-6769(p.197-219)) AN EVALUATION OF WIND PROFILE LAWS BY LEAST SQUARES TECHNIQUES. J. Robert Stinson, Harry Moses, and John E. Pearson (Argonne National Lab., Ill.).

Studies were made of the applications of the most generally accepted wind profile laws using a control set of data for comparison. The roles played by atmospheric stability and wind speed in shaping these wind profiles were also investigated. Four profile laws were studied: the power law, $\overline{U} = czP$; the logarithmic law, $\overline{U} = (U^*/K) \ln(Z/Z_0)$; Deacon's law, $\overline{U} = U^*/K(1-\beta)\,[(Z/Z_0)^{1-\beta} - 1]$; and log plus linear law, $\overline{U} = U^*/K\,[\ln(Z/Z_0) + \alpha(z/L)]$. In the equations, $\overline{U}$ is the average wind speed at the level, z, to be investigated; U^* is the friction or dynamic velocity and equal to $\sqrt{\tau/\rho}$, where τ is the shearing stress and ρ the density; z_0 is the roughness parameter; k is the von Karmen constant; p is the power law parameter; β is Deacon's parameter; α is Monin and Obukhov's constant; and L is the height of the substrate of dynamic turbulence. Of types of regression equations used to study Argonne data, the log plus linear regression equation gave the best general fit. The power law and logarithmic law both proved reasonably accurate, with the power law giving better fit by night and the logarithmic law during the day. Deacon's law, when applied by computing β from the profile data instead of the solution of a regression equation, did not compare favorably with the other laws studied. (M.C.G.)

14576 (ANL-6769(p.220-9)) MAN-MADE IONIZED COLUMNS IN THE ATMOSPHERE — A NEW TOOL FOR METEOROLOGICAL RESEARCH. Harry Moses, Ronald L. Martin, Jacob Kastner, and A. J. Ulrich (Argonne National Lab., Ill.).

The use of a high-energy proton or electron beam, directed vertically to act as a probe for the study of atmospheric processes is proposed. An outstanding feature of such an atmospheric probe is its capability to ionize a column of air repeatedly in a few microseconds and in approximately the same place. Characteristics of a vertical proton beam which may be generated by the Zero Gradient Synchrotron at the Argonne National Laboratory are discussed, and calculations are presented to provide an estimate of the ion concentration as a function of height in the atmosphere. The potential uses of an atmospheric ionized column for meteorological research are discussed. Such investigations include the artificial initiation of lightning, the production of atmospheric ozone resulting from lightning, and the line spectra associated with the lightning channel. Also presented is a method whereby a combination of the high-energy particle beam and infrared techniques may be used to determine the air circulation within a thunderstorm. Mention is made of the possible uses of a high-energy particle beam for aerospace sciences, such as the study of whistlers and electromagnetic radiation phenomena associated with the aurora and air glow. (auth)

14577 (ANL-6769(p.230-9)) EXPANSION OF ARGONNE'S SOIL CLIMATOLOGY PROGRAM. James E. Carson and Frank C. Kulhanek (Argonne National Lab., Ill.).

Three additional soil thermal parameters (moisture, density, and heat flux) were added to Argonne's climatological observation program. Methods used for measuring these parameters are described. (M.C.G.)

14578 (HW-78435(Vol.I)) THE OCEAN BREEZE AND GULCH DIFFUSION PROGRAMS. VOLUME I. Duane A. Haugen, ed. (Air Force Cambridge Research Labs., Laurence G. Hanscom Field, Bedford, Mass.); and James J. Fuquay, ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 1963. Contract AT(45-1)-1350. 247p. (AFCRL-63-791(I))

Field diffusion programs were conducted at Cape Canaveral, Florida, and Vandenberg AFB, California, during 1961 and 1962. These programs, nicknamed Ocean Breeze and Dry Gulch respectively, were undertaken to establish quantitative diffusion predictions for use as range safety tools at the missile test ranges. The programs culminated at each range with the installation of an automatic computer-controlled meteorological data acquisition and processing system now in continuous operation at the bases. These systems were named Weather Information Network Display (WIND) systems. The diffusion experiments that were conducted are described. Summaries of the resulting experimental data are given. (auth)

14579 (HW-79382) RAIN SCAVENGING OF PARTICULATES. R. J. Engelmann (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1, 1963. Contract AT(45-1)-1350. 233p.

The process of collection of particles by falling raindrops is discussed in detail, and related to the flow field of air about a raindrop, as inferred from the literature. An extensive literature review treats the theoretical predictions of collection efficiencies, and the contributions to collection by both the wake of the drops and by electrical charges. The present state of knowledge of scavenging by impaction is then summarized. A field experimental design is given. Special samplers which utilize water-sensitive paper to record individual drops and their particulate content are described and pictured. Several experiments were conducted using artificial rain in the outdoors with zinc sulfide tracer particles. The measured efficiencies obtained therefrom are presented as functions of drop and particle size, and as functions of the dimensionless impaction parameter,

K. Comparisons are made to the theoretical predictions of Langmuir, and to the measurements with freely falling drops made by Kinzer and Cobb, Walton and Woolcock, and McCully, et al. Four main characteristics of the efficiencies as based on the drop cross sectional area are found: (1) higher efficiencies for drops of about 0.4 mm diameter, (2) efficiencies greater than 1.0 with all drops for particles larger than 13 microns, (3) a rapid increase in efficiency with particle size in the general region of ten microns diameter, and (4) an apparent minimum for all particle sizes and drop sizes of about 0.8 mm diameter. The explanation offered for these characteristics utilizes the classical inertial impaction of particles on the leading side of the drops, with additional wake effects, and the action of electrostatic and gravitational forces. Particles that narrowly miss the drops may be drawn into the wake by fluid convergence and electrical attraction. They fall therein with respect to the drop, and impact on the upper side of the drop. This favors the collection of the larger particles. The wake vortices of the larger drops, however, are shed from the drops and the chance of wake collection is reduced. An error analysis reveals that the correction used for the anisokinetic flow of the air samplers may contribute substantial error to the measured scavenging efficiencies. This anisokinetic correction is discussed in some detail. The distribution of particles on the air filters and the effects of wettability of the scavenged particles are also discussed. Recommendations for immediate future research include determination of the washout coefficient for snow through bulk precipitation measurements, and experiments in natural rain to determine scavenging efficiency as a function of both drop and particles size, as well as of wettability. (auth)

14580 (PG-Report-551) THE BIOLOGY OF THE SOLWAY FIRTH IN RELATION TO THE MOVEMENT AND ACCUMULATION OF RADIOACTIVE MATERIALS. X. WEATHER, MAY 1962 TO APRIL 1963. M. Bailey, E. J. Perkins, and B. R. H. Williams (United Kingdom Atomic Energy Authority. Production Group. Chapelcross Works, Annon, Dumfriesshire, Scotland). 1963. 30p.

Climatological data are presented for the meteorological station that operates at Chapelcross as part of the investigation of the Solway Firth. These values are compared with other stations in the region, and the climatological trends during the period are summarized. The stations at Chapelcross and Carlisle are selected as typical estuarine exposures and, from the results, it is deduced that the winter of 1962–63 was unusually severe. (auth)

14581 (TID-7677(p.348-67)) INNOVATIONS AND DEVELOPMENTS IN AIR POLLUTION STUDIES. David H. Slade (Weather Bureau, Washington, D. C.).

Studies of atmospheric pollution, diffusion, and transport are reviewed. The constant-level tetrahedron balloon ("tetroon") program to study air flow and to demonstrate the technique is described. Wind persistence, diffusion climatology, wind speed, and vertical diffusion of natural radioactive gases are also being studied. (M.C.G.)

14582 (TID-7677(p.384-91)) THETA-N SYSTEM FOR TURBULENCE MEASUREMENTS. Walter M. Culkowski and Duane H. Turner (Weather Bureau, Oak Ridge, Tenn.).

Recent advances in applied optical instrumentation permitted an extremely accurate, reliable, and versatile wind statistics system to be developed. Its basic principle is to obtain the differential of wind movement directly, then obtain other information by simple logic circuits. This system eliminates the ambiguities of conventional systems. (auth)

14583 CLIMATOLOGICAL ESTIMATES OF DIFFUSION CONDITIONS IN THE UNITED STATES. C. R. Hosler (Weather Bureau, Washington, D. C.). Nucl. Safety, 5: No. 2, 184-92(Winter 1963-64).

In the evaluation of potential hazards of radioactivity releases, the dilution capacity of the atmosphere must be taken into account. Results of studies of regional patterns of slow atmospheric dilution are collated to indicate areas where air pollution problems are probable. The parameters studied include wind speed, low-level inversions, subsidence inversion and stagnation episodes, mixing depths, and time-space considerations. It is concluded that atmospheric dilution is not an important criterion in reactor siting studies. (D.L.C.)

14584 FIELD DEVICE FOR DETERMINING COORDINATES AND POWER OF NUCLEAR EXPLOSIONS. S. Semenyuta. Voennyi Vestn., No. 12, 107-8(1963).

A simple device used in conjunction with a second meter was developed for use in the field to determine the direction, height, power, and distance (within 4–30 km) to the epicenter of a nuclear explosion. The instrument consists of: a compass; a plumb bob; an angle gauge; a plate with a distance and a second scale; a wind gauge; a sight; a table of explosive powders based on cloud height 100 sec after the blast; an axis and screw clamp; a stand; and a ground pin. Also, a table is provided for determining the power of the explosion from the time of flash and the height of cloud ascent. One third of the number of seconds that elapses from the moment of flash to the arrival of the sound wave is numerically equal to the distance in kilometers from the place of explosion to the observation point. Directing the device towards the explosion manually, the angle of the radioactive cloud height is measured 100 sec after the blast. The power of the explosion is read from the table on the basis of the time of arrival of the sound wave. The direction to the blast is taken from the compass. (OTS)

14585 SOME RADIO-FREQUENCY EFFECTS OF THE JULY 9, 1962, NUCLEAR DETONATION. A. T. Jusick (Univ. of Florida, Gainesville), T. D. Carr, A. G. Smith, and J. May. 11p. (CONF-374-3)

From American Physical Society Southeastern Section, Lexington, Ky., Nov. 1963.

Radiofrequency signals received at 5, 15, 18, and 22.5 Mc following the Starfish high-altitude nuclear test are analyzed. The receiving stations are located in Chile and at the time of the signal receptions were aimed at Jupiter and Saturn. (T.F.H.)

PHYSICS

General

14586 (AD-416438) PROJECT VELA FINAL TECHNICAL REPORT. Charles E. Phillips (Granger Associates, Palo Alto, Calif.). Mar. 6, 1962. Contract AF33(600)-43122. 97p.

Design of a prototype antenna system for use in detecting nuclear explosions by means of a backscatter technique is discussed. All antenna systems and techniques known to the art were studied, and the type of antenna which should be used with a backscatter detection system was determined. Separate antenna systems for transmitting and receiving may be necessary and will be permissible. A model (or models) was constructed, and antenna characteristics were measured. (auth)

14587 (CONF-416-1) STANDING CAPILLARY-GRAVITY WAVES OF FINITE AMPLITUDE. Paul Concus (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 30, 1963. Contract W-7405-eng-48. 6p.

From American Physical Society Division of Fluid Dynamics, Cambridge, Mass., Nov. 1963.

The uniqueness condition previously utilized is considered. The condition, which excludes certain fluid depths, is shown to be physically unacceptable because it is essentially impossible to satisfy in practice. The resulting invalidation of the perturbation method is discussed, and a revision is presented, which invokes the presence of viscosity and allows retention of the previously obtained solutions. The revision may also be applied to the work of other authors who utilized the same method to solve other standing-wave problems. Two minor corrections are also given. (auth)

14588 (DP-878) MÖSSBAUER EFFECT IN FERREDOXIN. William L. Pillinger and John A. Stone (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Jan. 1964. Contract AT(07-2)-1. 15p.

The Mössbauer effect in ferredoxin enriched with Fe^{57} was measured at 298, 195, and 77°K. A two-line velocity spectrum was observed at each temperature. The hyperfine splitting, the shift from zero velocity, the line widths, and the absorption strength all increase with decreasing temperature. The spectrum behaves as a doublet, split by the electric quadrupole interaction. Line broadening at room temperature suggests the presence of additional unresolved splitting. The magnitude of the shifts and splittings in ferredoxin are consistent with an interpretation of covalently bound iron. (auth)

14589 (IS-828) AN EXPERIMENTAL APPROACH TO A SIMPLIFIED BAND STRUCTURE OF THE RARE EARTH METALS. Karl A. Gschneidner, Jr. (Ames Lab., Ames, Iowa). [Feb. 1964]. Contract [W-7405-eng-82]. 22p. (CONF-405-2)

The very low and room temperature heat capacities, Hall coefficients, magnetic susceptibilities, spectral data, and electrical resistivities of the rare earth metals are reviewed and examined. Simplified band models are proposed for α- and γ-cerium, europium, and ytterbium. Future experiments for studying the band structures are suggested. (D.L.C.)

14590 (NIRL/R/60) P.L.A. PROGRESS REPORT, 1963. R. C. Hanna and J. M. Dickson, eds. (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England). Jan. 1964. 132p.

Development and operation of the accelerator are summarized, together with research progress in accelerator and nuclear physics. The development of experimental apparatus is also reported. (D.C.W.)

14591 (ORNL-3481) SORPTION OF GASES BY VAPOR-DEPOSITED TITANIUM FILMS. R. E. Clausing (Oak Ridge National Lab., Tenn.). Mar. 1964. Contract W-7405-eng-26. 51p.

Results are summarized for an investigation of the sorption rates of gases on vapor-deposited titanium films. The usefulness of such films for ultrahigh speed vacuum pumping is appraised. The sorption of hydrogen, deuterium, oxygen, nitrogen, carbon monoxide, carbon dioxide, water vapor, helium, argon, and methane onto titanium films was measured for a variety of circumstances using techniques and apparatus developed for this specific purpose. The information obtained and techniques evolved in this study have shown that large-scale getter pumping is feasible and can be a very effective means of pumping many gases. Sticking fractions larger than 0.8 were obtained for hydrogen, deuterium, oxygen, nitrogen, carbon monoxide, and carbon dioxide. The experiments have shown that the sticking fraction for gases on vapor-deposited films is a function of the deposition conditions. There is strong evidence to support the supposition that conditions which favor the formation of a porous, fine-grained film structure with a large surface-to-volume ratio produce films with the highest sorption rates. The technique for measuring sticking fractions is new and in many respects unique. It utilizes a very large sorption surface, thus minimizing the perturbing effect of the instrumentation and evaporation apparatus and reducing the hazard of film contamination due to small leaks in the system or outgassing of system components. The method gives especially good accuracy for measurements of sticking fractions approaching unity. The quantity of gas adsorbed, the gas flux onto the getter surface, and the gas flux leaving the getter surface are measured directly. Any two of these three independent measurements can be used to determine the sticking fraction, thereby providing a means of checking the data. The evaporation techniques, substrate surface, and substrate area were chosen to very nearly duplicate the conditions likely to be encountered in the practical application of large-scale getter pumping. (auth)

14592 (PR-P-60) PHYSICS DIVISION PROGRESS REPORT, OCTOBER 1–DECEMBER 31, 1963. (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). 58p. (AECL-1902)

Research progress on nuclear structure, lattice dynamics and structure, nuclear models, nuclear theory, fission, and cosmic radiation is summarized, together with detector, spectrometer, and counter development. Computer use and programming is also indicated. (D.C.W.)

14593 (TID-20240) WALL EFFECTS IN NONEQUILIBRIUM STATISTICAL MECHANICS. Progress Report No. 2. Henry B. Hollinger (Rensselaer Polytechnic Inst., Troy, N. Y.). Feb. 1964. Contract AT(30-1)-3036. 11p.

The statistical mechanical models for determining the

role of walls in the approach to equilibrium for particles are ensembles of systems composed of a finite number of particles obeying nonrelativistic classical or quantum mechanics. The walls are rigid, reflecting walls. The model for the evaluation of transport properties in dilute gases near walls is the one described by the classical Boltzmann equation modified so that correlations introduced by wall collisions are taken into account. The ultimate goal is a comprehensive treatment of wall effects in the statistical mechanical theory of irreversible processes. (N.W.R.)

14594 (JPRS-23436) NEWS OF HIGHER EDUCATIONAL INSTITUTIONS MINISTRY OF HIGHER AND SECONDARY SPECIALIZED EDUCATION USSR, RADIOPHYSICS SERIES. Translation of Izvestiya Vysshikh Uchebnykh Zavedenii, Radiofizika, 6: No. 4, 655-871(1963). 422p. (OTS-64-21677)

Separate abstracts were prepared for eight of the twenty-five papers included. One paper on low-frequency oscillations of plasma in gravitational and magnetic fields was previously abstracted in NSA. The remaining papers deal with atmospheric, solar, and lunar radio emissions; electromagnetic wave absorption by water vapor; and theory for electronic and hydraulic systems. (D.C.W.)

For abstracts of individual papers see: 14686, 15212, 15348, 15349, 15350, 15351, 15352, and 15353.

14595 SECOND-ORDER ELECTRIC FIELD DUE TO A CONDUCTION CURRENT. Don A. Baker (Los Alamos Scientific Lab., N. Mex.). Am. J. Phys., 32: 153-7(Feb. 1964).

Assuming that the fields of a moving-point charge as computed from the retarded Liénard–Wiechert potentials give valid descriptions for moving electrons, it is shown that no net second-order static electric field of the type discussed by Rosser appears on the axis of a charge-neutral circular loop carrying a steady current. An argument is given for the nonexistence of such residual electric fields around any closed, charge-neutral region in which the current flow is time independent. (auth)

14596 ON THE HYPOTHESIS OF THE VARIATION OF THE GRAVITATIONAL CONSTANT, AND ON SOME OF ITS CONSEQUENCES. Arrigo Finzi (Università, Rome). Ann. Phys. (N. Y.), 26: 411-17(Feb. 20, 1964).

The hypothesis that k varies according to a law $k = k_0[1 + a(V/c^2)]$, where a is a constant of the order of unity, and V is the gravitational potential is considered. The observation of white dwarfs within galactic clusters could provide a test of the hypothesis. It is shown that the problem connected with the existence of a critical mass for neutron stars may perhaps be solved by using the same hypothesis. (auth)

14597 THE EQUIVALENCE OF INERTIAL AND PASSIVE GRAVITATIONAL MASS. P. G. Roll, R. Krotkov, and R. H. Dicke (Princeton Univ., N. J.). Ann. Phys. (N. Y.), 26: 442-517(Feb. 20, 1964).

Torsion balance measurements of the difference in ratios of gravitational to inertial mass for different materials were carried out, confirming to higher precision the null results obtained 60 years ago by Eötvös and assumed by Einstein as the Principle of Equivalence upon which the General Theory of Relativity is founded. If the parameter $\eta(A,B)$ is defined as

$$\eta(A,B) = [(M/m)_A - (M/m)_B]/\tfrac{1}{2}[(M/m)_A + (M/m)_B],$$

where M and m represent the passive gravitational and inertial masses respectively of materials A and B, then the results from the most sensitive torsion balance used enable us to conclude with 95% confidence that $|\eta(Au,Al)| < 3 \times 10^{-11}$. Stated more exactly, the various measurements of η, obtained from the gravitational acceleration toward the sun, gave a substantially Gaussian distribution with mean value $\eta(Au,Al) = (1.3 \pm 1.0) \times 10^{-11}$. The probable error quoted for the mean is based upon the observed scatter in results from individual data runs, assuming a Gaussian distribution. The importance of the Eötvös experiment to contemporary gravitational theories is discussed, and the earlier measurements of Eötvös and J. Renner are examined critically. The torsion balance and associated equipment used in the present experiment are described in detail, along with the considerations involved in their design. Methods of data analysis are also discussed extensively and tables of individual results are presented. (auth)

14598 FLUORESCENCE AND STIMULATED EMISSION FROM $Gd_2O_3:Nd^{3+}$ AT ROOM TEMPERATURE AND 77°K. B. H. Soffer and R. H. Hoskins (Korad Corp., Santa Monica, Calif.). Appl. Phys. Letters, 4: 113-14(Mar. 15, 1964).

The observation of stimulated emission near 1.08μ from a single crystal of $Gd_2NO_3:Nd^{3+}$ is reported. The emission arose from the $^4F_{3/2}$ to $^4I_{11/2}$ transitions. The spectral linewidths of the most intense lines are 20 to 30 cm^{-1} at room temperature and 8 cm^{-1} at 77°K. An EGG FX-33 flashlamp was used. The fluorescence lifetime was ~120 μsec. (C.E.S.)

14599 ON MAGNETO-HYDRODYNAMIC SHOCK WAVES. Sigve Tjoetta (Univ. of Bergen, Oslo). Arbok Univ., Bergen, Mat.-Nat. Ser., No. 8, 12p.(1962).

The propagation of a magnetohydrodynamic wave of finite amplitude is discussed. The magnetic field and the density are such as to make the gyrofrequency for ions and electrons small compared to the collision frequency for the particles. With propagation perpendicular to the magnetic field, it turns out that a simple differential equation (Burger's equation) for the wave motion can be obtained by linearizing the diffusion terms and taking into account the nonlinear effects in a first approximation in the Mach-number. This equation can be solved exactly. The structure of the shock wave is discussed briefly. (auth)

14600 A THEOREM ON ENERGY FLOW IN THE MOTION OF A FLUID WITH HIGH ELECTRICAL CONDUCTIVITY IN WHICH A MAGNETIC FIELD IS GENERATED. Cataldo Agostinelli. Atti Acad. Naz. Lincei, Rend., Classe Sci. Fis., Mat. Nat. (8), 34: 471-4(May 1963). (In Italian)

The motion of a non-viscous fluid of high electrical conductivity in which a magnetic field is generated is considered. There is a significant relation relative to the total energy flow across any fixed closed surface belonging to the field of motion of the fluid. If the elements of the magnetic field and of the motion are periodic with respect to time, the total energy flow across any fixed surface immersed in the field of motion is equal, for a given period, to the flow of the magnetic stress and pressure across the surface considered. (J.S.R.)

14601 THE MAGNETODYNAMIC RADIOACTIVE EQUILIBRIUM OF A SPHERICAL GASEOUS MASS UNIFORMLY ROTATING AND GRAVITATING. Jacopa Vacca. Atti Accad. Sci. Torino. I. Classe Sci. Fis., Mat., 97: 1014-26(1962-63). (In Italian)

The differential equations that control the magnetodynamic radiative equilibrium of a highly electroconductive spherical gaseous mass in uniform rotation exposed to gravitational action and initially immersed in a constant axial magnetic field were determined. (tr-auth)

14602 A MEAN VALUE THEOREM IN MAGNETOHYDRODYNAMICS DERIVING FROM THE GENERALIZED VIRIAL THEOREM FOR A FLUID MASS OF INFINITE ELECTRICAL CONDUCTIVITY EXPOSED TO SELF-GRAVITATION. Tino Zeuli. Atti Accad. Sci. Torino. I. Classe Sci. Fis., Mat. Nat., 97: 1245-53(1962-63). (In Italian)

The virial theorem is generalized to magnetohydrodynamics in the case of a fluid mass of infinite electrical conductivity exposed to self-gravitation, and a mean value theorem is deduced from it. (tr-auth)

14603 ADSORPTION OF HELIUM FOUR ON SARAN CHARCOAL AT TEMPERATURES BELOW 5°K. J. R. Dacey and M. H. Edwards (Royal Military Coll. of Canada, Kingston, Ont.). Can. J. Phys., 42: 241-50(Feb. 1964).

Isotherms for the adsorption of helium on Saran charcoal in the region of the boiling point of helium and for pressures above 7×10^{-4} torr were determined and isosteric heats of adsorption calculated. The average density of the adsorbed helium is 0.249 g cm^{-3}. It is concluded that the first two layers of helium on the carbon are in a solid state while higher layers are a liquid. The view that Saran charcoal contains a system of micropores 10 to 15 Å in width is confirmed. (auth)

14604 THE IONIC ENTRAPMENT AND THERMAL DESORPTION OF INERT GASES IN TUNGSTEN FOR KINETIC ENERGIES OF 40 ev TO 5 kev. E. V. Kornelsen (National Research Council, Ottawa). Can. J. Phys., 42: 364-81(Feb. 1964). (NRC-7745)

A clean polycrystalline tungsten wire was bombarded with monoenergetic ions of neon, argon, krypton, and xenon in the energy range 40 ev to 5 kev. The gas trapped in the tungsten was desorbed by then heating the wire to 2400°K at 66°K/second. Ion sticking probabilities determined from the quantities of gas desorbed ranged from ~0.6 for all gases at 3 kev to $<10^{-5}$ at ion energies (ev) ~4 times the ion atomic number. From the variation of the desorption rates with temperature, six activation energies of thermal desorption were found that were not dependent on the ion or its incident energy. The lowest four (33 to 63 kcal/mole) are believed to be associated with gas trapped within a few atom layers of the metal surface, and the highest (102 kcal/mole) with normal impurity diffusion in the bulk tungsten. (auth)

14605 A CALCULATION OF THE GRUENISEN PARAMETERS, $\gamma(n)$, FOR INERT GAS SOLIDS. G. M. Graham (Univ. of Toronto). Can. J. Phys. 42: 563-8(Mar. 1964).

An algebraic derivation of the moments of the frequency distribution for a cubic lattice is reported, with the assumption that the interatomic forces can be described by a general pair potential. Numerical calculations of $\gamma(n)$ for n = 3, 0, 1, 2, 4, 6, and 8 were made for a f.c.c. lattice with a 6; 12 potential. (R.E.U.)

14606 STRUCTURE OF SLOW IONIZING SHOCKS. M. Soubaramayer. Compt. Rend., 258: 436-9(Jan. 13, 1964). (In French)

A previous analysis of the internal structure of ionizing shocks is extended to slow shocks. The results indicate that the slow ionizing shock behaves like a slow magnetohydrodynamic shock in which all the gas is electrically conductive. Also, the beginning of the slow ionizing shock is similar to that of a slow magnetohydrodynamic sub-shock. (tr-auth)

14607 A FREE, PLANE, LAMINAR JET OF INCOMPRESSIBLE FLUID IN WHICH THE VISCOSITY EQUALS THE MAGNETIC DIFFUSIVENESS. Rene Moreau (Universite, Grenoble, France). Compt. Rend., 258: 440-3 (Jan. 13, 1964). (In French)

Solutions of the continuity, Navier, and Maxwell equations are presented for a fluid of finite conductivity. Magnetic fields transverse and longitudinal with respect to the axis of the jet are considered. The results indicate that the flow will always be super-Alfven. (D.C.W.)

14608 LATERAL STABILIZATION OF AN ELECTRON BEAM BY AN IONIC SPACE CHARGE. ACTION OF A GRID PLACED IN THE SLIP SPACE. Jean-Baptiste Moreau. Compt. Rend., 258: 1437-9(Feb. 3, 1964). (In French)

A vacuum tube in which the pressure is controlled to any percent was constructed. An electron beam, crossing through the residual gas, creates ions which contribute to the neutralization of the space charge. The ions in the beam could be maintained and self-focused because of a grid placed very near the gun. However, this could be done only for gas pressures higher than 10^{-4} torr, in fact incompatible with the operation of a h-f tube. (tr-auth)

14609 EXPONENTIAL NATURE OF ABSORPTION OF NUCLEAR BETA RADIATIONS. B. Somalinga Sastry and Swami Jnanananda(Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 1: 411-14(Dec. 1963).

The nature of the process of the exponential absorption of beta radiations from the isotopes P^{32}, Bi^{210}, Tl^{204}, and Sr^{90}–Y^{90} was investigated employing composite absorbers. It was found that absorption is a balanced effect between two phenomena, namely filtration and slowing. Filtration effect is a consequence of the Rutherford multiple nuclear scattering, whereas the slowing effect is a consequence of the inelastic collisions of beta particles with atomic electrons. The deviations from exponential absorption observed with greater absorber thicknesses may be attributed to the predominance of the slowing effect. It is also found that the closeness with which the absorption obeys the exponential relation increases with increasing atomic number, according to a linear relation. Similar results were obtained in an alloy of platinum (60 per cent) and rhodium (40 per cent). (auth)

14610 MASS SPECTROMETRIC STUDY OF NEUTRAL PARTICLES SPUTTERED FROM Cu BY 0- TO 100-ev Ar IONS. James R. Woodyard and C. Burleigh Cooper (Univ. of Delaware, Newark). J. Appl. Phys., 35: 1107-17(Apr. 1964).

A low-pressure magnetically confined argon arc discharge was used in a mass spectrometer ion source to study low-energy (0 to 100 ev) sputtering of polycrystalline copper. Target bombarding ion current densities ranged from 60 to 200 $\mu A/cm^2$. Neutral particles were studied. Cu atoms and Cu_2 molecules were detected. The mass ratio of analyzed Cu_2 molecules to Cu atoms increased with bombarding ion energies to about $5\frac{1}{2}\%$ at ion energies of 100 ev. Target voltages for appearance of Cu atoms and Cu_2 molecules were −19 and −50 v, respectively. No Cu_3 molecules were detected; if they were present, it was estimated that the ratio $^{189}Cu_3$ to Cu^{63} is less than 0.09%. The method was found to be promising for the study of neutral particles in low-energy sputtering. Yield curves agree well with results of other observers; sensitivities of 7×10^{-4} atoms/ion were attained, and this figure can be improved. (auth)

14611 METHODS OF DETERMINING CENTROID X-RAY WAVELENGTHS: CuKα AND FeKα. M. Mack, W. Parrish, and J. Taylor (Philips Lab., Irving-on-Hudson, N. Y.). J. Appl. Phys., 35: 1118-27(Apr. 1964).

For an exact solution of the Bragg equation it is neces-

sary that there be a one-to-one correspondence (equivalence) between the angular measure θ and the wavelength measure λ. Because the aberrations inherent in all x-ray diffraction profile measurements distort the profile, it is necessary to correct any given measure (peak, centroid, etc.) for all aberrations. The only angular measure of powder diffractometer profiles that can be corrected to a high degree of accuracy is the centroid. To realize the greater accuracy inherent in the centroid method, accurate centroid spectral wavelengths are required. Centroids of CuKα and FeKα two-crystal spectrometer profiles prepared by Bearden were calculated and corrected for axial divergence, distortions arising from variation in absorption across the spectral distributions, crystal asymmetry, and other factors. To determine the centroid wavelength it is necessary to truncate the profile; equivalence of λ and θ is maintained by truncating the powder and spectral profiles in the same manner. Four methods for systematically truncating the profiles have been published; the methods are evaluated and the superiority of one of the methods is demonstrated. It is shown that the centroid wavelength is a function of integration (wavelength) range, primarily as a result of inclusion or exclusion of the Kα satellite group within the truncated profile. The two-crystal spectrometer profiles are compared with models based on a Cauchy distribution. The necessity for additional spectral data before reference centroid wavelengths can be established is discussed. (auth)

14612 COMPRESSION OF MAGNETIC FIELD BETWEEN TWO SEMI-INFINITE SLABS OF CONSTANT CONDUCTIVITY. Andrew Paton (U.K.A.E.A., Aldermaston, Berks, Eng.) and William Millar. J. Appl. Phys., 35: 1141-6(Apr. 1964).

A uniform magnetic field is compressed in a circuit containing two semi-infinite slabs of constant conductivity σ. The separation l of the slabs decreases uniformly according to $l = l_0 - vt$. An equation involving the magnetic Reynolds number $R_m = \sigma\mu_0 l_0 v$ is derived for the magnetic field in the gap. Expressions are given for the magnetic and electric fields everywhere up to the instant of collision. These expressions are evaluated for several values of R_m and it is found that the ratio of Joule energy density to magnetic energy density at the surfaces of the slabs is fairly close to unity throughout the motion. For $R_m \gg 1$ it is shown that the maximum magnification of the initial field is approximately $R_m/8$. (auth)

14613 PRESSURE-INDUCED TRANSFORMATIONS TO CRYSTAL STRUCTURES OF LOWER PACKING DENSITY. Franz K. Weddeling (Duke Univ., Durham, N. C.). J. Appl. Phys., 35: 1201-2(Apr. 1964).

An explanation of pressure-induced polymorphic transitions from close-packed structures to nonclose-packed arrangements of atoms is attempted and compared with recent experimental data for ytterbium. (auth)

14614 ELASTIC CONSTANTS OF CsBr AND CsI FROM 4.2°K TO ROOM TEMPERATURE. J. Vallin, O. Beckman, and K. Salama (Uppsala Univ.). J. Appl. Phys., 35: 1222-3 (Apr. 1964).

The elastic constants of pure single crystals of CsBr and CsI were measured at liquid-helium, liquid-nitrogen, and room temperatures. For CsBr, the values of c_{11}, c_{12}, and c_{44} at 4.2°K are 3.437, 1.035, and 0.999 in units of 10^{10} N/m^2. The corresponding values of CsI at 4.2°K are 2.737, 0.793, and 0.825×10^{10} N/m^2. The elastic constants give the Debye temperature 148.8°K for CsBr and 125.6°K for CsI. The infrared resonance frequencies calculated from compressibility data are in agreement with those obtained from infrared spectroscopy. (auth)

14615 RADIATION HARDENING IN ALKALI-HALIDE CRYSTALS. John S. Nadeau (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 35: 1248-55 (Apr. 1964).

Hardening by gamma irradiation was investigated in eleven alkali halides with the rocksalt structure. The linear dependence of the flow stress upon the one-half power of the F-center concentration, as previously observed in LiF and KCl, was also observed in these new substances. The rate of hardening with concentration was found in all cases to be consistent with that to be expected for nonsymmetrical defects. Comparisons were also made between the amount of hardening per defect and the lattice spaces available to certain specific defects. The only clear correlation was with a halogen atom in the interstitial space at coordinates 0, ¼, ¼ in the unit cell. (auth)

14616 THERMIONIC EMISSION OF VAPOR-DEPOSITED MOLYBDENUM CATHODES. M. N. Huberman (Atomics International, Canoga Park, Calif.) and R. A. Holzl. J. Appl. Phys., 35: 1357-8(Apr. 1964).

Improved uniformity of electron emission over the surface of molybdenum cathodes was obtained by vapor deposition of molybdenum. A preferred crystallographic orientation relative to the cathode surface was found. (R.E.U.)

14617 IMPULSE BREAKDOWN BETWEEN CO-AXIAL ELECTRODES AT LOW PRESSURE. P. B. Barber, J. S. T. Looms, D. A. Swift, and B. A. Tozer (Central Electricity Research Labs., Leatherhead, Surrey, Eng.). J. Nucl. Energy, Pt. C, 6: 29-38(Jan.-Feb. 1964).

A capacitor bank of 9 to 20 μf, charged to 5 to 7 kv, was suddenly connected to a short coaxial gap having an electrode separation of 4 cm, filled with N_2 at pressures between 4 and 4×10^{-2} torr. It was observed that in spite of gap and external electric circuit symmetry, the discharge with a peak current of 10,000 to 60,000 amp always developed initially in one or more radial columns and never in a continuous luminous ring, and that the development of each radial column occurred in three distinct stages. When the switch was closed, the gap and cables were first charged and, when the gap broke down, discharged in a period of some 200 nanoseconds with an estimated peak current of 2000 amp. A dark period of 600 nanoseconds followed during which the discharge current of the capacitor bank built-up to a comparable value. An analysis of the discharge development was made by means of current and voltage oscillograms, streak photographs, microwave transmission measurements, and spectrograms. It was found that the copper electrodes ablated strongly, but no emission of Cu lines was observed. Thus the discharge occurred essentially in nitrogen, despite the formation of both anode and cathode spots. It is suggested that discharges supplied by locally stored energy may precede the main flow of current in many experimental arrangements in which the electrodes, the connections, and the storage capacitance do not constitute a transmission line and therefore have more than one natural discharge frequency. (auth)

14618 RELEASE OF GRAVITATIONAL ENERGY IN GENERAL RELATIVITY. W. H. McCrea (Royal Holloway Coll., Englefield Green, Surrey, Eng.). Nature, 201: 589 (Feb. 8, 1964).

An interpretation is presented of Schwarzschild's solution of Einstein's field equations. (R.E.U.)

14619 ON THE MOBILITY OF INTERSTITIALS. P. Gosar (Nuclear Inst. "Jozef Stefan", Ljubljana, Yugoslavia). Nuovo Cimento (10), 31: 781-97(Feb. 16, 1964).

A temperature-dependent Green's functions method is used for the calculation of the mobility of interstitials. A quantum-mechanical expression for ν_0 in the formula $\nu = \nu_0 \exp[-U/kT]$ for the jumping frequency from one interstitial site to a neighbor is derived. The theory avoids the concept of the transition state, used in classical theories. The interactions of interstitials with phonons are taken explicitly into account. (auth)

14620 THE FERMI SURFACE OF BERYLLIUM. J. H. Terrell (Brandeis Univ., Waltham, Mass., and Massachusetts Inst. of Tech., Cambridge). Phys. Letters, 8: 149-51(Feb. 1, 1964).

Energy band calculations are reported for hcp beryllium with good agreement with previous results for the Fermi surface. (R.E.U.)

14621 DISCUSSION OF SPIN-SPIN RELAXATION FORMULAE AND EXPERIMENTS. R. L. Peterson (National Bureau of Standards, Boulder, Colo.). Phys. Letters, 8: 158-9(Feb. 1, 1964).

Corrections to previous papers on longitudinal spin-spin relaxation are pointed out, and applications of corrected formulas to recent nuclear spin-spin relaxation data are discussed. (R.E.U.)

14622 SPIN WAVES IN LIQUID He^3. G. Lill (Technische Hochschule, Munich). Phys. Letters, 8: 171-2 (Feb. 1, 1964).

The time-dependent Hartree-Fock method was used to investigate the propagation of undamped spin waves in He^3 in the presence of an external magnetic field. (R.E.U.)

14623 ON THE INTERFERENCE BETWEEN STREAMING AND COLLISION IN TRANSPORT EQUATIONS. K. H. Michel and E. Verboven (Universiteit, Nijmegen, Netherlands). Phys. Letters, 8: 176-7(Feb. 1, 1964).

The equation for the one-electron distribution function, $(\partial f/\partial t)_{field} + (\partial f/\partial t)_{collision} = 0$, is solved in the linear approximation and evaluated. The effects of nonseparation of external field effects and collision effects on transport coefficient evaluation are discussed. (R.E.U.)

14624 A POSSIBLE MODIFICATION OF CLASSICAL ELECTRODYNAMICS. R. C. Stabler (Radio Corp. of America, Princeton, N. J.). Phys. Letters, 8: 185-7 (Feb. 1, 1964).

A classical theory of electrodynamics is considered that omits self-forces and self-energies of the charged particle undergoing radiative processes. It is shown that for the classical electron to radiate energy while being accelerated, there must be two such electrons accelerated, and that radiation scatter by a single free electron is due only to quantum effects. (R.E.U.)

14625 MASS-SPECTROMETRIC STUDY ON THE ENERGY DISTRIBUTION OF SPUTTERED PARTICLES. F. Kirchner and A. Benninghoven (Universitat, Cologne). Phys. Letters, 8: 193-4(Feb. 1, 1964). (In German)

A retarding potential method of mass spectrometry was used to study the variation of the energy distribution of sputtered Al^+ and K^+ particles from semipure Al and from Duraluminum using a Hg ion beam of 500 to 3000 ev. (R.E.U.)

14626 MÖSSBAUER EFFECT STUDIES OF NUCLEAR HYPERFINE STRUCTURE IN Tm^{169} IN Fe_2Tm. R. L. Cohen (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 134: A94-8(Apr. 6, 1964).

The nuclear hyperfine structure of the 8.4-kev transition in Tm^{169} in Fe_2Tm was studied as a function of temperature from 4 to 400°K using the Mössbauer effect. The main source of the nuclear hyperfine interaction is the Tm 4*f* electron shell that is polarized through the exchange interaction with the iron atoms, which are themselves ferromagnetically coupled. A theoretical analysis based on the assumption that the thulium ion ground-state energy levels are determined only by this exchange interaction is successful in explaining the observed temperature variation of the magnetic and electric nuclear interactions. The magnetic hyperfine interaction in the nuclear ground state is $1.05 \pm 0.05 \times 10^{-5}$ ev at 4°K. The nuclear quadrupole moment of the 8.4-kev state was estimated to be −1.3 b, the ratio μ_e/μ_g of the nuclear magnetic moments is −2.17 ± 0.10, the magnetic moment of the Tm ion in Tm metal at 4°K is 6.4 ± 0.3 μ_B, and the value $\langle r^{-3} \rangle$ for the 4*f* electrons was measured as 12.5 ± 0.7 au. These results are compared with the theoretical values and other experimental results. (auth)

14627 EFFECT OF PRESSURE ON THE CURIE TEMPERATURE OF RARE-EARTH METALS. I. GADOLINIUM. Lawrence Baylor Robinson, Frederick Milstein, and A. Jayaraman (Univ. of California, Los Angeles). Phys. Rev., 134: A187-92(Apr. 6, 1964).

An experimental investigation was undertaken for the purpose of learning the effect of interatomic distance on the magnetic exchange interaction of ferromagnetic rare-earth metals. The first material studied is gadolinium. A toroidal-shaped specimen of gadolinium was subjected to pressures up to about 40 kbar. The gadolinium toroid served as a transformer core. A constant input voltage was applied and the output voltage was studied as a function of pressure and temperature. The Curie temperature, obtained from the output voltage, was found to be depressed linearly with pressure at a rate of −1.60°C/(kbar) up to 21.5 kbar. Between 21.5 and 26.7 kbar a phase transition to a nonferromagnetic state occurred. (auth)

14628 NEW EXPERIMENTAL LIMIT ON VELOCITY-DEPENDENT INTERACTIONS OF CLOCKS AND DISTANT MATTER. K. C. Turner and H. A. Hill (Princeton Univ., N. J.). Phys. Rev., 134: B252-6(Apr. 13, 1964). (PUC-1963-119)

An experiment analogous to that of Kennedy-Thorndike and the ammonia-beam experiment of Cedarholm, Bland, Havens, and Townes was performed using the Mössbauer effect in Fe^{57}. A Co^{57} source was on the rim and an iron absorber near the center of a centrifuge. The frequency shift between the rotating source and absorber was measured as a function of the angular position relative to the fixed stars. An anomalous velocity-dependent interaction of clocks with a field derived from distant matter would be expected to cause a frequency shift $\Delta\nu/\nu = 2\gamma u \cdot v/c^2$, where γ is a constant, v the relative velocity of source and absorber, and u the velocity of the laboratory relative to a reference frame in which distant matter has an isotropic velocity distribution. The value of the component of γu lying in the earth's equatorial plane was found to be 220 ± 840 cm/sec. (auth)

14629 TEMPERATURES OF THE VOLUME MINIMA AND STRATIFICATION REGIONS FOR ^3He–^4He MIXTURES. Eugene C. Kerr (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Letters, 12: 185-7(Feb. 24, 1964).

Experiments were performed to investigate the effects of

He^3 on lowering of the λ point of He^4. Discrepancies in different methods are resolved. (R.E.U.)

14630 SENSITIVE DETECTION OF PURE QUADRUPOLE SPECTRA OF NUCLEI (10^{15} TO 10^{18} cm^{-3}) NEAR IMPURITIES IN NaCl. R. E. Slusher and E. L. Hahn (Univ. of California, Berkeley). Phys. Rev. Letters, 12: 246-8 (Mar. 9, 1964).

Nuclear quadrupole interactions of Na and Cl nuclei located at noncubic sites in impure NaCl in concentrations of 10^{15} to 10^{18} cm^{-3} were detected. The effects of K^+ and Br^- impurities were studied. (R.E.U.)

14631 LIQUID HELIUM AS A BARRIER TO ELECTRONS. W. T. Sommer (Stanford Univ., Calif.). Phys. Rev. Letters, 12: 271-3(Mar. 16, 1964).

An experiment is described that indicates that liquid helium appears as an energy barrier of more than one electron volt to electrons. (R.E.U.)

14632 BIQUADRATIC SUPEREXCHANGE. Nai Li Huang and R. Orbach (Univ. of California, Los Angeles). Phys. Rev. Letters, 12: 275-6(Mar. 16, 1964).

The origin of the biquadratic exchange integral used to explain the energy level spectrum of Mn pairs in MgO is discussed and an explicit expression is derived for the integral to find the ordinary bilinear exchange integral. (R.E.U.)

14633 SIGN OF THE CONDUCTION ELECTRON CONTRIBUTION TO THE ELECTRIC FIELD GRADIENT IN METALS. F. Borsa and R. G. Barnes (Ames Lab., Ames, Iowa). Phys. Rev. Letters, 12: 281-4(Mar. 16, 1964). (IS-826)

Evidence is presented for the lattice and conduction electron contributions to the electric field gradient having opposite sign in the case of pure β-tin, and correlation between the conduction electron contribution and the anisotropic Knight shift in metals is suggested. (R.E.U.)

14634 THE STATISTICS OF IONIZATION CURRENTS IN GASES BETWEEN PARALLEL PLATES. P. M. Davidson (University Coll. of Swansea, Wales). Proc. Phys. Soc. (London), 83: 259-73(Feb. 1964).

The statistical scatter of the current at various times and under both flash and constant illumination are investigated, together with current fluctuations at large times and under constant illumination with a potential < the sparking potential. The probable time for the occurrence of a spark under the latter conditions is also calculated. The effects of space charge are considered. (D.C.W.)

14635 NEW THEORETICAL MODELS OF PRECURSOR EFFECTS IN INTENSE GAS DISCHARGES. N. J. Phillips (English Electric Co. Ltd., Whetstone, Leics, Eng.). Proc. Phys. Soc. (London), 83: 275-81(Feb. 1964).

The so-called precursor effects that occur in intense electrical discharges in gases are discussed. Two possible theories of the phenomenon are presented. One considers the photoionization effects induced by the discharge acting as a radiation source, and the other considers the electric field effects remote from a typical azimuthal type discharge. The relative merits of the two approaches are discussed, and a comparison is made with recent experimental work. (auth)

14636 TRANSPORT COEFFICIENTS OF A DEGENERATE ELECTRON "LIQUID." EFFECT OF COULOMB INTERACTION ON DETERMINATION OF FERMI SURFACES. Setsuo Misawa (Nihon Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 30: 786-803(Dec. 1963).

On the basis of Landau's theory of a Fermi liquid, the effect of Coulomb interaction is examined to clarify its effects on the various effective masses of electrons that are imbedded in the sea of uniform positive charge. By solving the kinetic equation that describes the kinetic evolution of the distribution function of mutually interacting quasiparticles, general expressions are obtained for the complex dielectric constant tensor of an electron "liquid" in terms of Landau's two-particle correlation function. Because of the strictness of this kinetic equation in the sense of many-body correlation effects of the Coulomb interaction, the results obtained are completely rigorous and, contrary to the results of the usual high density expansion, can be applied to real metals (disregarding the fact that the correlation function is considered as being given a priori). Plasmon frequency, attenuation constant of ultrasonic waves, screening constant of the Coulomb interaction, anomalous skin effect, cyclotron resonance frequency, and other related problems are discussed from this standpoint. (auth)

14637 ON THE LIGHT VELOCITY IN THE THEORY OF FINITE DEGREE OF FREEDOM. Roland Koeberle and Takao Tati (Univ. of São Paulo, Brazil). Progr. Theoret. Phys. (Kyoto), 30: 911-12(Dec. 1963).

The photon self-energy is examined in a finite degree of freedom theory to determine any contradictions in the constancy of light velocity. (R.E.U.)

14638 TYPE II OR LONDON SUPERCONDUCTORS. B. B. Goodman (Centre de Recherches sur les Très Basses Témperatures, Grenoble, France). Rev. Mod. Phys., 36: 12-19(Jan. 1964).

The theory of type II superconductors (for which the penetration depth is greater than the coherence length) is reviewed. The theoretical results are compared with experimental observations. (T.F.H.)

14639 THIRD INTERNATIONAL CONFERENCE ON THE MÖSSBAUER EFFECT. Held at Cornell Univ., Ithaca, N. Y., 4-7 Sept., 1963. Alan J. Bearden, ed. Rev. Mod. Phys., 36: 333-503(Jan. 1964).

Separate abstracts were prepared for 11 of the 13 complete papers presented; 2 were previously abstracted for NSA. 106 abstracts of contributed papers are included. (R.E.U.)

For abstracts of individual papers see: 14640, 14641, 14642, 14643, 14644, 14645, 14646, 14647, 14648, 14649, and 14650.

14640 APPLICATION AND INTERPRETATION OF ISOMER SHIFTS. D. A. Shirley (Univ. of California, Berkeley). Rev. Mod. Phys., 36: 339-52(Jan. 1964).

A derivation of equations useful in interpreting isomer shifts in the Mössbauer effect is outlined, following isotope-shift theory closely. The present and potential applications of isomer shift measurement to chemistry and metal physics are discussed, and some conclusions about chemical bonds are pointed out. An equation relating isomer shifts to nuclear deformation is given and applications to the study of various types of collective nuclear excitation are discussed. Limitations of the method are discussed. 49 references. (R.E.U.)

14641 GENERAL ASPECTS OF NUCLEAR HYPERFINE INTERACTIONS IN SALTS OF THE RARE EARTHS. R. L. Moessbauer (California Inst. of Tech., Pasadena). Rev. Mod. Phys., 36: 362-71(Jan. 1964).

General features and experimental results are discussed for recoilless resonance absorption studies of hyperfine interactions in rare earth salts. 24 references. (R.E.U.)

14642 RECENT DEVELOPMENTS IN RARE-EARTH MÖSSBAUER STUDIES. [PART] I. P. Kienle (Technische Hochschule, Munich). Rev. Mod. Phys., 36: 372-8(Jan. 1964).

Recent nuclear resonance fluorescence experiments with low-energy gamma rays of rare-earth nuclides using the Mössbauer effect are described. Hyperfine interactions of nuclear states with a rare-earth ion in a solid and isomeric shifts of transitions in rare earths are discussed. 31 references. (R.E.U.)

14643 RECENT DEVELOPMENTS IN RARE-EARTH MÖSSBAUER STUDIES. [PART] II. S. G. Cohen, I. Nowik, and S. Ofer (Hebrew Univ., Jerusalem). Rev. Mod. Phys., 36: 378-85(Jan. 1964).

Rare-earth iron garnets were used as absorbers in Mössbauer studies of the magnetic properties of the rare-earth ions. The sublattice of the rare-earth ions in the garnet displays a spontaneous magnetization below the Curie temperature (550°C) that is correlated with the existence of an effective magnetic field at the rare-earth nuclei. Results are given for Dy^{161} in dysprosium iron garnet, for the 2^+ level of Dy^{160}, for Eu^{3+} in europium iron garnet, and for Tm^{169} in thulium iron garnet. 22 references. (R.E.U.)

14644 RARE EARTH MAGNETISM IN RELATION TO THE MÖSSBAUER EFFECT. R. J. Elliott (Oxford Univ.). Rev. Mod. Phys., 36: 385-91(Jan. 1964).

The magnetic properties of the rare earths and compounds and alloys of the rare earths are discussed. Mössbauer experiments, which clarify the properties, are described. 58 references. (R.E.U.)

14645 MAGNETISM OF DILUTE ALLOYS. W. Marshall, T. E. Cranshaw, C. E. Johnson, and M. S. Ridout (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Rev. Mod. Phys., 36: 399-409(Jan. 1964).

Dilute ferromagnetic alloys with iron, nickel, or cobalt as host metal and dilute alloys of transition metals with hosts such as copper, gold, silver, or zinc were studied using the Mössbauer effect. (R.E.U.)

14646 ON THE THEORY OF RESONANT SCATTERING OF GAMMA RAYS BY NUCLEI BOUND IN CRYSTALS. R. L. Moessbauer and D. H. Sharp (California Inst. of Tech., Pasadena). Rev. Mod. Phys., 36: 410-17(Jan. 1964).

An attempt is made to give a physical description of the processes in which a gamma quantum is resonantly scattered or absorbed by nuclei bound in a crystal structure. The discussion includes a description of the time development of these processes as well as a critical study of the limits imposed upon such a description by the laws of quantum mechanics. (auth)

14647 LATTICE DYNAMICAL ASPECTS OF THE RESONANCE ABSORPTION OF GAMMA RAYS BY NUCLEI BOUND IN A CRYSTAL. A. A. Maradudin (Westinghouse Electric Corp., Pittsburgh). Rev. Mod. Phys., 36: 417-32(Jan. 1964).

Modifications of the lattice vibrations caused by an impurity nucleus in a host crystal and their effects on the absorption spectrum of the perfect host crystal are discussed. The "no-phonon," or Mössbauer, absorption cross section, the "one-phonon" absorption cross section, and the second-order Doppler shift are discussed in resonant absorption of gamma rays by nuclei in crystals. 61 references. (R.E.U.)

14648 OPTICAL ANALOGS OF THE MÖSSBAUER EFFECT IN SOLIDS. R. H. Silsbee and D. B. Fitchen (Cornell Univ., Ithaca, N. Y.). Rev. Mod. Phys., 36: 432-6(Jan. 1964).

An electronic analogy to the Mössbauer effect is described using classical and quantum mechanical comparisons. Some solid-state gamma-ray spectroscopic experiments are described. (R.E.U.)

14649 FERRIHEMOPROTEIN HYDROXIDES: A CORRELATION BETWEEN MAGNETIC AND SPECTROSCOPIC PROPERTIES. P. George, J. Beetlestone, and J. S. Griffith (Univ. of Pennsylvania, Philadelphia). Rev. Mod. Phys., 36: 441-63(Jan. 1964).

Optical absorption spectra and magnetic moments were obtained from paramagnetic susceptibility measurements for hemoglobin, myoglobin, and peroxidase. Mössbauer scattering experiments were performed to study the bonding in ferrihemoprotein hydroxides. (R.E.U.)

14650 ISOTOPE BIBLIOGRAPHY. Compiled Through August 1, 1963. Rev. Mod. Phys., 36: 496-503(Jan. 1964).

A bibliography is given for isotopes in which the Mössbauer effect was observed. Included are Fe^{57}, Ni^{61}, Zn^{67}, Kr^{83}, Sn^{119}, I^{129}, Sm^{149}, Eu^{151}, Sm^{152}, Gd^{155}, Tb^{159}, Dy^{161}, Er^{166}, Tm^{169}, Yb^{170}, W^{183}, W^{182}, Re^{187}, Ir^{191}, Ir^{193}, and Au^{197}. (R.E.U.)

14651 ON THE DETERMINATION OF A MATRIX ASSOCIATED WITH THE SYSTEM OF MAGNETOHYDRODYNAMIC DIFFERENTIAL EQUATIONS FOR AN INCOMPRESSIBLE IDEAL FLUID WITH INFINITE ELECTRIC CONDUCTIVITY. Mircea Vasiu. Studia Univ. Babes-Bolyai, Ser. Math.-Phys., No. 2, 103-11(1962). (In Rumanian)

A matrix associated with a system of magnetohydrodynamic differential equations with particular linear derivatives and with constant coefficients for an incompressible fluid with infinite electric conductivity was derived. In order to simplify the problem, the displacement current, nonelectromagnetic mass forces, and heat transfer within the fluid are not considered. The fluid is assumed to be in a constant uniform magnetic field. The G. C. Moisil method was used for further calculations of the matrix associated with the equation system. (R.V.J.)

14652 THE FIELD OF A CHARGED FILAMENT UNIFORMLY MOVING PAST A CONDUCTING SEMIPLANE. B. M. Bolotovskii and G. V. Voskresenskii (Lebedev Inst. of Physics, Moscow). Zh. Tekhn. Fiz., 34: 11-15(Jan. 1964). (In Russian)

Calculations were made of the field and emission spectrum of charged and current-carrying filaments in uniform motion in a vacuum at the boundary of an ideally conducting semiplane. (tr-auth)

14653 NANOSECOND PULSE BREAKDOWN OF SOME SMALL GAPS. Yu. E. Nesterikhin, V. S. Komel'kov, and E. Z. Meilikhov. Zh. Tekhn. Fiz., 34: 40-52(Jan. 1964). (In Russian)

Descriptions are given of a device for measuring nanosecond pulse breakdown in gaps under various pressures. An additional intensifying spark was used to speed breakdown. The system functions with 3 discharges of which two are optically joined dischargers that produced two strongly synchronized (with the accuracy to 2×10^{-10} sec) pulses with 25 kw amplitudes. A description is also given of a two-electrode vacuum device with changeable electrodes, controlled (to 10^{-3} cm) distances, and variable gas composition. (R.V.J.)

14654 MEASUREMENTS OF GAS DENSITY BEHIND A SHOCK WAVE IN A SHOCK TUBE BY AN ELECTRON BEAM METHOD. E. P. Busygin and G. K. Tumakaev

(Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 122-7(Jan. 1964). (In Russian)

Data are given on gas density variations. Measurements were made on an Ar-filled shock tube (p_1 = 3 to 10 mm Hg and M number from 3.0 to 10). (tr-auth)

14655 ELECTROMAGNETIC FIELD OF A TURN WITH ALTERNATING CURRENT OVER A CONDUCTING LAYER. V. P. Shmelev and Yu. M. Shkarlet. Zh. Tekhn. Fiz., 34: 131-41(Jan. 1964). (In Russian)

The electromagnetic field of a turn with alternating current (ω) situated over a finite-thickness layer with conductance (σ) was investigated in quasistationary approximation. An analysis was made of the asymptotic field dissociation according to $1/\sqrt{\omega\mu\sigma}$. The results are presented as complete elliptical integrals. For the case $\omega = 0$, the statistical magnetic field is described by a converging series. (R.V.J.)

14656 PROCEEDINGS OF THE 1963 MIDWEST CONFERENCE ON THEORETICAL PHYSICS. Meeting held at University of Notre Dame, May 31–June 1, 1963. Notre Dame, Ind., University of Notre Dame, 1963. 301p.

Various topics in theoretical physics were discussed, including the dispersion of sound in monatomic gases, the Boltzmann equation, plasma kinetics, quantum electrodynamics, broken symmetries and massless particles, the bootstrap method in strong interactions, complex angular momentum in perturbation theory, the Regge pole hypothesis, spin one-half particles in parity-nonconserving interactions, nuclear reaction theory, superconducting tunneling, electron-phonon systems, irreversible processes, S-matrix and field theory, wave equations for high-spin particles, Coulomb scattering wave functions, symmetry properties and biophysics, Bose-Einstein condensation and the grand canonical ensemble, and the ortho-para transition in molecular hydrogen. Separate abstracts were prepared for 19 of the 24 papers. Three papers were previously abstracted in NSA. (C.E.S.)

For abstracts of individual papers see: 14657, 14752, 14931, 14932, 14933, 14934, 14935, 14936, 14937, 15013, 15014, 15015, 15016, 15123, 15124, 15304, 15305, 15306, and 15406.

14657 NON-EQUILIBRIUM PROPERTIES OF POLARONS. L. Kadanoff (Univ. of Illinois, Urbana). p.166-78 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

Electrons interacting with longitudinal optical phonons in highly polar crystals such as alkali halides or silver halides are considered. The transport properties of these polarons are described. (C.E.S.)

14658 OPTICAL MASERS. Proceedings of Symposium, New York, N. Y., April 16, 17, 18, 19, 1963. Jerome Fox, ed. Microwave Research Institute Symposia Series. Volume XIII. Brooklyn, N. Y., Polytechnic Institute of Brooklyn, 1963. 678p. Available from Interstate Publishers, New York. $15.00.

The research, development, theory, mechanisms, properties, performance, and applications of optical masers are discussed in the 50 papers presented. (C.E.S.)

14659 PROCEEDINGS OF THE EASTERN THEORETICAL PHYSICS CONFERENCE, OCTOBER 25-26, 1963. Chapel Hill, N. C., University of North Carolina, 1963. 146p.

Various topics in theoretical physics were discussed including equilibrium statistical mechanics, second-order phase transitions, collective motion in many-body systems, Toeplitz determinants and Coulomb gases, superconducting condensation energy, complex spectra, group theory, momentum distributions in boson systems, quantum observations and measurements, equivalence of states, effects of strong interactions in peratization theory, π-p interactions, inelastic effects in π-N interactions, magnetic and electric geons, unitary symmetry, perturbation theory, fermion propagators, Yukawa field theory, Lamb shift calculations, lattice thermal conductivity, intramolecular statistics of chain molecules, and the application of Lie groups to the nuclear many-body problem. Separate abstracts are prepared for 16 of the 24 papers presented. Three papers were previously abstracted in NSA. (C.E.S.)

For abstracts of individual papers see: 14751, 14938, 14939, 14940, 14941, 15004, 15005, 15006, 15007, 15008, 15125, 15126, 15307, 15308, 15309, and 15310.

14660 PROGRESS IN NUCLEAR PHYSICS. VOLUME 9. O. R. Frisch, ed. A Pergamon Press Book. New York, The Macmillan Company, 1964. 313p. $15.00.

Separate abstracts were prepared for each of the 6 sections in the volume. Spark chambers, semiconductor counters, theoretical techniques of high-energy beam design, structure analysis of collision amplitudes, interactions of strange particles with nuclei, and electromagnetic properties of the muon are discussed. Contents of previous volumes are given. (R.E.U.)

For abstracts of individual papers see: 14270, 14271, 14694, 14913, 14914, and 15290.

14661 VISCOELECTRIC MAGNETOHYDRODYNAMIC ANALOGY. Thomas P. Anderson (Northwestern Univ., Evanston, Ill.). 4p. (CONF-414-6)

From Conference on Direct Energy Conversion, Argonne, Ill., Nov. 1963.

An analogy is established between the flow of a conducting fluid in a magnetic field and a class of fluids exhibiting viscosity changes in the presence of applied electric and magnetic fields. The analogy can be used to solve problems associated with the production of kilogauss fields and the simulation of the electromagnetic-fluid dynamic coupling. (R.E.U.)

14662 AN INTERPRETATION OF THE MÖSSBAUER SPECTRA OF SOME TIN COMPOUNDS IN TERMS OF THE VALENCE STATE OF THE TIN ATOM. H. Cordey-Hayes (Univ. of Birmingham, Eng.). 21p. (CONF-303-16)

From 3rd International Conference on the Mössbauer Effect, Ithaca, N. Y., Sept. 1963.

The Mössbauer spectra of twenty inorganic compounds of tin were studied. The isomeric chemical shift results are correlated with the electronic structures of the valence states of the tin atom and an estimate of the ionicities of the bonding orbitals made. In addition, a nuclear quadrupole interaction splits the absorption line into two components in many of the divalent compounds studied. Here the results are interpreted in terms of the p-character and hybrid nature of the bonding and nonbonding orbitals. Measurements were also made with several organic tin compounds. By correlation with the inorganic compound data the electronegativities of the organic groups were estimated. (auth)

14663 CESIUM NEUTRAL AND ION EMISSION FROM CARBURIZED AND OXYGENATED POROUS TUNGSTEN. A. Y. Cho and H. Shelton (TRW/Space Tech. Labs., Redondo Beach, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Preprint 64-11, 6p, $1.00. (CONF-392-6)

From Aerospace Sciences Meeting, New York, Jan. 1964.

Experiments on porous tungsten emitters in which special measures were taken to control surface conditions are reported. Ultra-high vacuum was maintained, emitters were designed to allow prolonged heating to 2000°K, capability for surface sputtering was provided, and controlled amounts of impurity carbon or oxygen could be introduced. It was found that oxygen decreases neutral emission, but increases critical temperature. Carbon decreases neutrals and decreases the critical temperature, but raises emissivity. Calcium increases neutrals and increases critical temperature. (R.E.U.)

14664 SOFT X-RAY PRODUCTION YIELDS BY 1.5 Mev PROTONS. W. T. Ogier, G. J. Lucas, J. S. Murray, and T. E. Holzer (Pomona Coll., Claremont, Calif.). 10p. (CONF-417-7)

From American Physical Society Meeting, Pasadena, Calif., Dec. 1963.

Thick-target yields of x rays with wavelengths from 1.5 to 44 Å were measured as functions of bombarding proton energy in the neighborhood of 1.5 Mev for C, Al, Ti, Fe, Cu, Mo, Ag, and Ta. X-ray production cross sections computed from these yields are in satisfactory agreement with existing theoretical excitation cross section calculations considering current estimates of fluorescence yields. (auth)

14665 RADIOGRAPHIC FILM PACKAGE. Ernest T. Larson, Jr. (to General Aniline and Film Corp., New York). U. S. Patent 3,124,683. Mar. 10, 1964. Filed Feb. 8, 1960.

A radiographic film package for radiation of 500 kv and higher is described that is comprised of an emulsion coating on one side only of the film and lead screens on both sides with a cardboard interface on the uncoated side. (R.E.U.)

Accelerators

Refer also to abstract 14216.

14666 (BNL-6940) LIQUEFIED GAS LEVEL INDICATOR FOR H_2 AND N_2. J. G. Cottingham and V. J. Kovarik (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT-30-2-GEN-16. 9p.

Utilization of the difference of thermal conduction in the gaseous and liquid phases of cryogenic fluids provides a means of accurately sensing the interphase boundary. This principle is used to develop a liquefied gas level indicator to display, alarm, and automatically fill liquefied H_2 and N_2 targets and target reservoirs used with Brookhaven accelerators. (auth)

14667 (CEA-2342) LE PERCUTEUR DE FAISCEAU DE SATURNE. CALCUL DU CHAMP MAGNETIQUE ET DES TRAJECTOIRES. VERIFICATIONS EXPERIMENTALES. (The Beam-kicker System of the Synchrotron Saturne. Magnetic Field and Particle Orbit Computations. Experimental Results). M. Gouttefangeas, A. Katz, and G. Rastoix (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 33p.

The beam-kicker system is briefly described. An analysis of its operation based on the sampling method is presented, together with two methods for computing the magnetic field produced by a set of endless conductors near a conducting shield where eddy currents are circulating. The first method leads to the resolution of a bi-dimensional Laplace equation with first kind boundary conditions (Dirichlet problem). The second method translates to electromagnetism the electrical images method currently used in electrostatics and yields the magnetic field as the sum of a triple series expansion in the general case of a set of conductors located in a parallelepipedic box. The results obtained in computation of the perturbation of the particle motion due to the beam-kicker are compared with the experimental data. (auth)

14668 (CEAL-1010) STABILITY OF BEAM IN RADIOFREQUENCY SYSTEM. Kenneth W. Robinson (Cambridge Electron Accelerator, Mass.). Feb. 27, 1964. Contract [AT(30-1)-2076]. 11p.

The stability of the circulating beam in a radiofrequency system with large beam loading is investigated. The results are applied to the 3-Bev electron-positron storage ring under design at the Cambridge Electron Accelerator. It is found that for this type of system, in which there are no large transients, it should be possible to use most of the radiofrequency power to supply the radiation losses of the circulating beam and only dissipate a small fraction of the power in the r-f cavities. (auth)

14669 (CERN-64-2) CHROMATIC ABERRATIONS IN QUADRUPOLE MULTIPLETS. E. Regenstreif (Rennes, France. Université. Faculté des Sciences and European Organization for Nuclear Research, Geneva). Dec. 13, 1963. 106p.

Explicit formulas for the chromatic abberations of a composite lens system are derived. Applications are made to quadrupole doublets and triplets with particular attention to symmetric systems and stigmatic operation. The feasibility of choosing operating conditions leading to minimum aberrations is demonstrated. (auth)

14670 (CERN-64-5) A NEW "SPLIT-POLE" QUADRUPOLE LENS. A. Ašner, P. Bossard, and F. Rohner (European Organization for Nuclear Research, Geneva). Jan. 30, 1964. 34p.

The theory of the split-pole quadrupole lens is presented; and the design and performance of a lens with a 20-cm aperture, an overall width of 50 cm, a length of 1.5 m, and a maximum field gradient of 930 gauss/cm are described. (D.C.W.)

14671 (CERN-64-9) RADIOACTIVITY INDUCED IN MATERIALS BY HIGH-ENERGY PARTICLES. M. Barbier (European Organization for Nuclear Research, Geneva). Jan. 11, 1964. 83p.

Induced radioactivity at high-energy particle facilities was studied. Data on activity in the CERN proton cyclotron and on the proton activation of numerous elements are included. Formulas for determining the activity as a function of flux and for obtaining the radiation field are given and demonstrated. A danger parameter characteristic of the irradiated element is also defined and demonstrated. The gamma intensity between the pole pieces of the cyclotron is calculated in agreement with measurements. (D.C.W.)

14672 (CERN-64-10) ACCELERATION IN A PROTON SYNCHROTRON BY MEANS OF A TRAVELLING WAVE STRUCTURE IN THE PASS-BAND REGION. W. Schnell (European Organization for Nuclear Research, Geneva). Feb. 11, 1964. 9p.

Some characteristics of traveling-wave guides operating in the pass-band region are investigated and compared with those of systems of resonant cavities. The r-f parameters that might be obtained with one embodiment of this structure are listed. (D.C.W.)

14673 (JINR-P-1507) VYSOKOCHASTOTNYI VYVOD TYAZHELYKH IONOV IZ TSIKLOTRONA. (Radio-Frequency Extraction of Heavy Ions From the Cyclotron). Yu. Ts. Oganesyan, G. Indreash, I. V. Kuznetsov, and R. Ts. Oganesyan (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1964. 9p.

A r-f external electric deflector was used to extract a beam of 75-Mev carbon ions from the accelerating chamber of a 150-cm cyclotron. When the constant voltage at the external planes was about 20 kv, the extraction coefficient was approximately 40%. The deflection system is described. (auth)

14674 (LNF-63/64) CRITERI DI PROGETTO DEGLI AMPLIFICATORI PER GLI IMPIANTI A RADIOFREQUENZA DELLE MACCHINE ACCELERATRICI ORBITALI IN RAPPORTO AI RECENTI PROGRESSI DELLA RADIOTECNICA. (Design Criteria for Amplifiers for the Radiofrequency Installation of the Orbital Accelerator with Respect to Recent Advances in Radiotechnology). Note No. 214. D. Fabiani (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). Sept. 29, 1963. 4p.

The most important design criteria for amplifiers for radiofrequency installations appears to be that the amplitude response of an apparatus (operating on a purely resistive load), within the pass band assigned, ought to be flat between ±2%. In order to assure this, the couplings between stages must be of the quadrupole type, composed of constant K asymmetric pass band filters in series. The advantages of such criteria are given. (J.S.R.)

14675 (LNF-63/70) CALCOLI PER L'OTTICA DI TRASPORTO DEI POSITRONI NELL'ACCELERATORE LINEARE DI FRASCATI. (Calculation of the Transport Optics of Positrons in the Frascati Linear Accelerator). Note No. 218. E. Ferlenghi and L. Mango (Italy. Comitato Nazionale per l'Energie Nucleare. Laboratori Nazionali, Frascati). Nov. 11, 1963. 29p.

The yield of an optical system for the transport of a positron beam from a target-converter across the linear accelerator to a storage ring is studied. In order to reduce the spread of the transverse moment of the particles from the converter and to improve the acceptance of the linac, an adaptation magnetic lens is inserted between target and linac. This lens can be considered as an optical system for positron beam transport. In the calculation of the yield of the system, an attempt is made to establish if the trajectory of the particle remains in the spatial region considered useful. The calculation uses the equations of motion of a particle in the field of the optical system and considers the geometric characteristics of the system itself. The effects of phase shifts of the particle accelerated in the optical system with respect to the radiofrequency wave are introduced. The results of numerical calculations are tabulated. (J.S.R.)

14676 (LNF-63/73) ELEMENTI DI PROGETTO E STATO DI AVANZAMENTO DI UN MODELLO DI MICROTRONE (2.5–5 Mev). (Design Elements and State of Advance of a Microtron Model (2.5–5 Mev)). Note No. 221. U. Bizzarri, M. Conte, R. Habel, and A. Vignati (Italy. Comitato Nazionale per l'Energie Nucleare. Laboratori Nazionali, Frascati). Nov. 28, 1963. 10p.

The principal characteristics of a microtron or electron cyclotron are briefly reviewed. The construction of the magnet, vacuum chamber, and the radiofrequency installation is described. (J.S.R.)

14677 (LNF-63/74) PROPOSTA DI INIEZIONE NEI SINCROTRONI ED ANELLI DI ACCUMULAZIONE MEDIANTE L'INNESCO DI UNA RISONANZA NELLE OSCILLAZIONI RADIALI DI BETATRONE. (Proposal for Injection in the Synchrotron and Storage Rings by Priming a Resonance in the Betatron Radial Oscillations). Note No. 222. A. Turrin (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). Dec. 2, 1963. 4p.

Three proposals for injection in the synchrotron and storage rings, based on resonance priming in betatron radial oscillations, are advanced. The first is to test an injection in the electron synchrotron with constant field, i.e., in continuous excitation, injecting with phase so that $|A| \ll |B|$. According to the second proposal, the same type of injection is made in AdA, constituted by a magnet with double focusing. The third proposal suggests the initiation of a series of calculations to estimate the injection yield in Adone when, in place of the pulsed deflector, a conventional deflector and a resonance perturbation act simultaneously. (J.S.R.)

14678 (MURA-679) PARTICLE DYNAMICS IN LINEAR ACCELERATORS. Phil Lee Morton (Midwestern Universities Research Assn., Stoughton, Wis.). Dec. 13, 1963. Contract AT(11-1)-384. 120p.

Thesis submitted to Ohio State Univ., Columbus.

Particle dynamics in a standing-wave Alvarez linear accelerator with quadrupole focusing magnets are treated. The previous single-particle theories are extended to take into account the coupling between the longitudinal and transverse motion of a particle. The hamiltonian governing the particle motion is derived and used to obtain an adiabatic invariant for particles that travel along the axis. From this hamiltonian the frequencies of small amplitude transverse and longitudinal oscillations are obtained as functions of the particle energy. The adiabatic invariant for on-axis particles is used to obtain the longitudinal oscillation amplitude. Next, the hamiltonian is transformed by the use of Moser theory to obtain a new hamiltonian, which is then used to treat the coupling between transverse and longitudinal particle motion. Specific results are illustrated in the case of the MURA linac for which the main coupling resonance is the one where the transverse oscillation frequency equals the longitudinal oscillation frequency. In this case, it is shown that transverse oscillations grow by less than 2%. Finally, the influence of the space-charged forces on the longitudinal particle motion is studied, and a limit on the total number of particles that can be accelerated is obtained. The space-charge limit is calculated for the MURA linac to be 50 mamp. (auth)

14679 (NIRL/R/52) MOVEMENT OF 3,000 TONS OF CONCRETE SHIELDING BLOCKS ADJACENT TO THE NIMROD MAGNET FOUNDATIONS. J. T. Delury, E. G. Higgins, and J. B. Mucklow (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England). Oct. 1963. 21p.

When the 140-ft long, 30-ft wide, 3,000-ton concrete radiation shield wall on Nimrod between the Magnet Room and Experimental Hall was moved some 50 ft it was thought desirable to measure foundation movements resulting to assess the effect on machine alignment. This report shows the readings taken in graphical form and assesses the effect of the shield wall movement on the foundations. (auth)

14680 (NP-13614) BUNCHIROVKA CHASTITS PERED NACHALOM USKORENIYA. (Beam Bunching

Before the Start of Acceleration). L. L. Gol'din and Yu. P. Sivkov (Akademiya Nauk S.S.S.R. Institut Theoreticheskoi i Eksperimental'noi Fiziki, Moscow and U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniya Atomnoi Energii). 1963. 22p.

Beam bunching in the strong focusing proton synchrotrons is considered. Methods of bunching the beam in the accelerators with high betatron oscillations frequencies are discussed. (auth)

14681 (NP-13617) FOCALISATION ET ÉTALONNAGE D'UN ACCÉLÉRATEUR VAN DE GRAAFF À ANALYSEUR MAGNÉTIQUE (these). (Focusing and Calibration of a Van de Graaff Accelerator by a Magnetic Analyzer (thesis)). Jean-René Pizzi (Lyon. Université). [1963]. 95p.

The determination of parameters influencing the quality of the beam and its control was studied. Two areas have received special emphasis: the problems of beam focusing which condition the stability of the accelerator and the problems connected to the convenient determination of the magnetic field. In the first part, the beam focusing in the accelerator and the magnetic analysis associated with it were investigated. The magnetic analyzer was considered from the angle of double focusing and some properties such as the formation of crossover were dealt with. The magnetic analyzer is controlled so that the double focusing occurs on the target at a distance of 3R from the magnet. The separation of the output slits was 1 mm, and the energy dispersion of the beam was of the order of 2 kev. The installation for the measurement of the field by nuclear magnetic resonance, using an autodyne oscillator, could detect a field variation of 0.06 gauss. The measurement of the oscillator frequency was made with a precision of 2×10^{-4}. The magnetic analyzer used permitted the energy calibration of the accelerator. A calculation of the error showed that the energy can be determined with a relative error of the order of 2×10^{-3}. (J.S.R.)

14682 (ORNL-3554) A FORTRAN PROGRAM FOR ESTIMATING RESIDUAL RADIATION LEVELS IN HIGH-ENERGY CHARGED-PARTICLE ACCELERATORS. J. B. Ball and C. B. Fulmer (Oak Ridge National Lab., Tenn.). Mar. 1964. Contract W-7405-eng-26. 13p.

A FORTRAN II program is described for utilizing cross section data for spallation products to obtain an estimate of the residual radiation from the bombardment of materials with high-energy particles. The program listing is included, together with sample input and output. (auth)

14683 (TID-7677(p.208-21)) GASEOUS RADIOACTIVITY ASSOCIATED WITH THE OPERATION OF THE RENSSELAER POLYTECHNIC INSTITUTE LINEAR ACCELERATOR. Robert M. Ryan (Rensselaer Polytechnic Inst., Troy, N. Y.).

Measurements made at the R.P.I. Linear Accelerator indicated that radioactive N^{13} and O^{15} are the most prominent gases that are being produced. The measurements were made with commercially available equipment. Surveys were also performed in the environment surrounding the linear accelerator when diffusion calculations indicated the environmental activity could be marginal on instrument sensitivity. Concentration guides for N^{13} and O^{15} were established. (auth)

14684 (UCLA-P-62) CALCULATION OF THE TRANSFORMATION MATRIX FOR A CYCLOTRON FRINGE FIELD. Arthur C. Paul (California. Univ., Los Angeles). Jan. 1964. Contracts AT(11-1)-34 and Nonr-233(44). 24p.

A Fortran program for the IBM 7090 was written to calculate the optical effect of a cyclotron's fringing field on an extracted negative ion beam. The program is discussed in terms of the first order ion optic theory of Penner and is applied to the UCLA 50-Mev cyclotron. The program is also applicable to an extracted positive beam. (auth)

14685 (UCRL-10626) BEVATRON OPERATION AND DEVELOPMENT. NO. 35, JULY–SEPTEMBER 1962. Kennith C. Crebbin and Rudin M. Johnson (California. Univ., Berkeley. Lawrence Radiation Lab.). Dec. 16, 1963. Contract W-7405-eng-48. 22p.

There was no Bevatron operation as the shutdown for shielding and injector changes continued. The old pole-face windings were removed and more trouble-free windings were installed. The r-f house was modified to allow for the new roof-block shielding. A new r-f accelerating electrode to eliminate harmonic resonances was installed. A magnet elevation survey was made on the bottom of the magnet and in the gap to provide data for future surveys on the bottom of the magnet only. The linear accelerator injector was tested at full energy (19.2 Mev) at currents up to 25 mamp. The ion source was run at 460 kv with up to 100-mamp currents available. The beam-transport-system magnets were completed, and the beam was run through part of the system. (auth)

14686 (JPRS-23436(p.238-60)) INVESTIGATION OF SYNCHROTRON OSCILLATIONS OF ACCELERATED PARTICLES WITH ACCOUNT OF BEAM-POSITION FEEDBACK. V. A. Bertulis. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 6: 775-84(1963).

The differential equations of excited nonlinear synchrotron oscillations are examined. The selection of the parameters for the accelerator and for the elements of the positional feedback system for the accelerated charged particle beam is considered. (auth)

14687 STABILIZATION OF BETATRON-MAGNET EXCITATION. Ladislav Sipek. Elektrotech. Obzor, 51: 233-7(1962).

A method is described to regulate the excitation voltage of a betatron magnet, comparable to the circuitry of a ferroresonant stabilizer, only that the nonlinear magnetic inductance is used instead of the nonlinear impedance, and the regulated voltage originates directly on the magnet terminals. Since the nonloaded impedance of both a capacitor or a choke coil can be used as linear impedance, there are two regulation possibilities: a circuit where a capacitor battery is connected in series with the magnet coil; and a circuit where a capacitor battery is connected parallel with the magnet and a choke coil connected in series to the parallel resonance. To compare the properties of the two regulation systems, expressions were derived to determine the attainable stability factor and the influence of grid-frequency fluctuations, and calculations were performed with the example of a 15 mev betatron. Despite the fact that each of the two regulation systems has certain advantages and disadvantages, they both can be considered equivalent and will, therefore, be installed in various Czechoslovak betatrons. It is mentioned that regulation of the excitation voltage of a betatron magnet also improves the stability of the gamma radiation produced by a betatron and increases the average radiation intensity. (OTS)

14688 PROTON ENERGY SPECTRA FROM A HIGH-FREQUENCY ION SOURCE. Krsto Prelec (Institut "Rudjer Bošković", Zagreb). Glasnik Mat.-Fiz. Astron., Ser. II, 18: 103-19(1963).

Measurements were made of the energy distribution of ions from a high-frequency ion source. The stopping-

potential method was used to obtain energy measurements. The influences of the shape of the extraction system, oscillator input power, magnetic field strength, gas pressure, and extraction voltage were determined. Results showed that the energy spectrum of ions from a high-frequency ion source is considerably wider than predicted by the simple Langmuir probe theory. (M.C.G.)

14689 EXTRACTION SYSTEMS OF A HIGH-FREQUENCY PROTON SOURCE. Krsto Prelec (Institut "Rudjer Bošković", Zagreb). Glasnik Mat.-Fiz. Astron., Ser. II, 18: 121-5(1963).

Experiments were carried out to determine the most convenient shape of the extraction system for a high-frequency ion source. An aluminum probe surrounded by a quartz tube was chosen as the extraction system. The effects of height, cross section, and shape were studied. Channels with the shape of the beam spreading under the influence of the space charge and with a combination of this shape and a cup shape were found to be most suitable. (M.C.G.)

14690 SOME CHARACTERISTICS OF A PULSED PROBE RF ION SOURCE. Shinji Suganomata (Hitachi Ltd., Ibaraki, Japan). Japan J. Appl. Phys., 3: 24-6(Jan. 1964).

A pulsed beam of 1 mamp was obtained by applying pulsed voltage to the probe of an r-f ion source. The operating characteristics of the source were examined. The required probe voltage depends upon the rise time of the voltage pulse, and the delayed response of the beam pulse to the voltage pulse was observed. A qualitative interpretation of the experimental results is given. (auth)

14691 PULSE SHORTENING EFFECT IN LINEAR ACCELERATORS. Hiromasa Hirakawa (Tokyo Univ.). Japan J. Appl. Phys., 3: 27-35(Jan. 1964).

The injection current into an electron linear accelerator has a threshold beyond which the emerging accelerated beam is unstable in the latter part of the pulses, resulting in partial or complete loss of the output current. An experiment and a theoretical analysis show that the effect is due to r-f excitation of the accelerator in an unwanted mode. Several ways to suppress the excitation are discussed. (auth)

14692 PROCEEDINGS OF THE SYMPOSIUM ON HIGH POWER ACCELERATOR APPLICATIONS HELD OCTOBER 13, 1961 IN NEW YORK, NEW YORK. Karl Eklund, ed. Proc. Symp. High Power Accelerator Appl., New York, 1961 (1962), 134p. Westbury, New York, Radiation Dynamics, Inc., 1962.

Separate abstracts were prepared for 5 of the 7 papers presented; one was previously abstracted for NSA and one, Pulsed Radiation Reactions, was not cleared by ANL for publication. (R.E.U.)

For abstracts of individual papers see: 13886, 14563, 14564, 14693, and 15386.

14693 POLARIZED ACCELERATOR BEAM EXPERIMENTS. Leon Madansky (Johns Hopkins Univ., Baltimore). Proc. Symp. High Power Accelerator Appl., New York, 1961, 10-20(1962).

The increasing interest in the availability of sources of polarized particles is prompted by the need for systematic studies of spin effects in nuclear reactions. A short discussion outlines experiments with polarized particles of low and intermediate energy. A discussion is then devoted to the description of proposals and designs of sources of polarized protons. The application of methods based on the magnetic separation of hydrogen atom hyperfine structure, as well as other methods, is outlined. (auth)

14694 THEORETICAL TECHNIQUES OF HIGH-ENERGY BEAM DESIGN. N. M. King. Progr. Nucl. Phys., 9: 71-116(1964).

The design criteria for efficient utilization of high-energy accelerator beams are discussed. Beam dynamics, basic beam elements, a quadrupole system design, a separated beam design, and special components associated with beam refinement are discussed. The beam layout design of the CERN proton synchrotron is given. 65 references. (R.E.U.)

14695 EFFECT OF EXTENDED FRINGING FIELDS ON ION-FOCUSING PROPERTIES OF DEFLECTING MAGNETS. Harald A. Enge (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instr., 35: 278-87(Mar. 1964).

The result of calculations on ion deflection and focusing is presented, for magnets that have realistic, extended fringing fields rather than sharply cutoff fringing fields. The most important effects of the change from sharp cutoff to extended fringing fields are: displacements of the beam center line at entrance and exit (a "zeroth-order" effect); and reduction of first-order z-direction ("vertical") focusing. When the pole boundaries are curved or an effective curvature is caused by the proximity of pole-piece corners, there are further first-order effects on the trajectories. These effects can be minimized, and in practice made negligible, by correct centering of the beam relative to the pole-piece corners at entrance and exit. (auth)

14696 MODULATION OF ELECTRONS AT THE INPUT COUPLER OF LINEAR ACCELERATOR FORMING SECTIONS. A. I. Zykov and E. K. Ostrovskii. Zh. Tekhn. Fiz., 34: 149-53(Jan. 1964). (In Russian)

Modulating effects of a high-frequency field in resonator type transition from rectangular to diaphragm waveguides, used as an accelerating system in forming sections, were calculated. It was found that such transitions in the forming section result in considerable contraction of the effective acceleration area, which is in agreement with experimental data. (R.V.J.)

14697 NON-LINEAR THEORY OF PLASMA WAVEGUIDES. Z. N. Kondratenko. Zh. Tekhn. Fiz., 34: 154-61(Jan. 1964). (In Russian)

Axially-symmetric propagation of electromagnetic waves in a cylindrical plasma waveguide was analyzed in small nonlinearity approximation. (R.V.J.)

14698 APPROXIMATION FORMULAS FOR Qz AND Qr IN A CYCLOTRON WITH A SECTIONED MAGNET SYSTEM. Yu. Ya. Lemba (Tartu State Univ.). Zh. Tekhn. Fiz., 34: 162-3(Jan. 1964). (In Russian)

An attempt was made to develop an approximation formula for Q_z in a sector cyclotron (operating as a synchrocyclotron) and to compare the results with the formula for Q_r (Q_z and Q_r are the numbers of vertical and radial betatron oscillations per revolution). The initial condition of resonance acceleration was taken to be infinite: $\zeta/\eta = \delta$ (where $\zeta = E/E_0$, $\eta = \langle H\rangle/\langle H_0\rangle$, $\delta = T/T_0$, E is the total energy of an equilibrium ion, $\langle H\rangle$ is the mean intensity of the magnetic field along an equilibrium orbit, and T is the period of the accelerating electric field. In order to achieve isochronous and ideal cyclotron operations it was assumed that $\delta = 1$ and $\eta = 1$. (tr-auth)

14699 VARIABLE ENERGY EXTRACTION FROM THE UCLA 50-Mev CYCLOTRON. Arthur C. Paul and Byron T. Wright (Univ. of California, Los Angeles). 25p. (CONF-417-5)

From American Physical Society Meeting, Pasadena, Calif., Dec. 1963.

A scheme for the extraction of a 25- to 47-Mev proton beam into a common external beam-transport system was studied for use with the UCLA 50-Mev cyclotron. The extraction is accomplished by stripping negative hydrogen ions with a thin foil. The magnetic field is held constant while the radius and azimuth of the stripping foil are chosen so that the trajectories for any energy cross at a common point outside the cyclotron vacuum tank. A small combination magnet placed at this crossover point bends the trajectories into a common beam-transport system. The feasibility of this scheme was studied by computing the ion-optic matrix for the cyclotron fringing field for 25, 30, 35, 40, and 45 Mev. The beam spot size calculation indicates a 100% extraction efficiency in this energy range. (auth)

Astrophysics and Cosmology

14700 (JPL-TM-33-111) PRELIMINARY RESULTS FROM MARINER-II SOLAR PLASMA EXPERIMENT. Marcia Neugebauer and Conway W. Snyder (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Nov. 15, 1962. Contract NAS7-100. 11p. (NASA-CR-50065; N63-17226)

A preliminary summary of the data received from the Mariner-II solar plasma experiment for the period August 29 through October 31, 1962, is presented. During this period, there was always a measurably large plasma flow from the direction of the Sun. The velocity of this ion motion was generally in the range 400 to 700 km/sec. Time variations, plasma density, and ion temperature are also discussed. (auth)

14701 (LADC-5692) CALCULATIONS OF OPACITIES FOR ASTROPHYSICS. Arthur N. Cox (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 25p. (CONF-431-1)

Opacities of a mixture of hydrogen, helium, and a small amount of heavier elements are given, and the methods for calculating them are described. (C.E.S.)

14702 (N63-14231) INTERPLANETARY GAS. VIII. ON THE ROLE OF RADIATIVE LOSSES. Peter Bodenheimer, John C. Brandt, and R. R. Robbins (California. Univ., Berkeley. Space Sciences Lab.). [1962]. 27p.

The radiative losses due to free-free transitions, free-bound transitions, and permitted and forbidden line emission were evaluated for all ions which are present in significant amounts in the extended solar corona from 4 to 215 sun radii. Most of the radiative losses occur within 15 sun radii, and are dominated by line emission in the extreme ultraviolet and x-ray wavelengths. In general, the radiative losses are found to be unimportant. The consequences of this result are discussed in terms of the semiempirical model recently presented by Brandt. (auth)

14703 (NP-13704) NEITRINNAYA SVETIMOST ZVEZD I NEITRAL'NYI TOK. (Neutrino Radiance of Stars and Neutral Current). E. P. Shabalin (Akademiya Nauk S.S.S.R. Institut Teoreticheskoĭ i Eksperimental'noĭ Fiziki and U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoĭ Energii). 1963. 13p.

The role of the process in which the nucleus passes from the excited state into the ground state by neutrino pair emission is considered. The consequences of the theory of weak interaction with neutral current for the processes causing the neutrino luminosity of stars are discussed. (auth)

14704 (TID-20306) HELIOCENTRIC COORDINATES OF MARS, 1800-2000. Joseph L. Brady and Edna Vienop (California. Univ., Livermore. Lawrence Radiation Lab.). May 1962. Contract W-7405-eng-48. 407p. (UCRL-Pub-132)

The heliocentric, equatorial, rectangular coordinates of Mars, referred to the mean equator and equinox of 1950.0, are tabulated at five-day intervals from 1800 to 2000 A.D. The motion equations and initial coordinates are included, and the numerical integration and the handling of observations are described. (D.C.W.)

14705 REDSHIFT AND DEFLECTION OF PHOTONS BY GRAVITATION: A COMPARISON OF RELATIVISTIC AND NEWTONIAN TREATMENTS. Austin J. O'Leary (City Univ. of New York, New York). Am. J. Phys., 32: 52-5(Jan. 1964).

Gravitational redshift of photons from a star and gravitational bending of the path of photons grazing the sun can be derived by using only Newton's laws and the idea of a photon as a particle of mass $h\nu/c^2$. The difference between the relativistic and Newtonian equations for gravitational redshift is too small to be detected and, therefore, gravitational redshift does not provide experimental verification of the general theory of relativity. On the other hand, a Newtonian treatment of gravitational bending of the path of photons gives only half the true amount of total deflection derived by Einstein in 1915 using general relativity. The case of gravitational bending is treated in some detail. (auth)

14706 SUPERNOVAE, NEUTRINOS, AND NEUTRON STARS. H.-Y. Chiu (Goddard Inst. for Space Studies, New York and Columbia Univ., New York). Ann. Phys. (N. Y.), 26: 364-410(Feb. 20, 1964).

The final stage of stellar evolution is studied from a theoretical point of view. Two types of stellar instabilities (hydrostatic and dynamical) are studied. It is concluded that at a temperature of $T \sim 6 \times 10^9$°K, both hydrostatic instability, which is induced by the photodisintegration of iron into helium (phase change), and dynamical instability, which is induced by the annihilation process of neutrino production, can cause a star to collapse to beyond recovery. Neutrino processes involving electron-neutrinos and μ-neutrinos prohibit any temperature rise in the star during the collapse phase. Hence the collapse will take place under zero temperature conditions ($kT \ll$ Fermi energy of electrons). The structure of static, zero temperature stars is reviewed. When the density is less than 10^9 gm/cm^3 the star is composed of ordinary ionized nuclei. When the mass approaches 1.4 $M_\odot$ the density reaches a value that the electron zero point energy (Fermi energy) exceeds the energy difference between isobars. Inverse beta reactions then take place, decreasing the number of electrons, causing instability (hydrostatic). Because of this instability, no star exists whose density ranges from 10^9 to 10^{13} gm/cm^3. After a density of 10^{13} gm/cm^3 is reached, inverse beta reactions have eliminated all but a very small number of electrons. No nuclei can exist and the star is predominantly made of neutrons. Such a high concentration of mass produces a large curvature of space-time near the star. General relativity theory is used to describe the structure of such stars. General relativity theory predicts the existence of singularities. Two kinds of gravitational singularities may exist, according to a static, general relativistic description of cold stars. One kind of singularity corresponds to a classical situation that, at the center of such a star the gravitational potential of a test body is equal to its rest energy. Hence matter "disappears" through this kind

of singularity. The other singularity corresponds to the same situation except the whole star "cuts itself off" from the rest of the universe by producing a large curvature near the star such that not even photons may leave it. It is indicated by work done in the past that a static description is probably unrealistic. Even in a gedanken sense, slowly adding material to a star will inevitably cause it to collapse dynamically. No completely satisfactory solution for a dynamically collapsing star has been found. The fate of collapsing massive stars (which are believed to be related to supernovas that occur at a rate of around one per hundred years per galaxy) is hence unknown, even in a theoretical sense. The surface of the remains of such stars, if visible at all, will have a temperature of around 10^6 to 10^7°K. Most of the radiation from such stars will be in the x-ray band and will not penetrate through our atmosphere. Hence, for the detection of such stars an orbiting telescope working in the near x-ray band will be most useful. (auth)

14707 THE INTEGRAL SPECTRUM OF SOLAR PROTONS MEASURED DURING A ROCKET FLIGHT FROM ANDOYA, NORWAY, ON DECEMBER 11th, 1962. F. Soeraas and B. Trumpy (Univ. of Bergen, Oslo). Arbok Univ. Bergen, Mat.-Nat. Ser., No. 22, 14p.(1963).

During a rocket flight from Andoya in northern Norway on December 11th, 1962 the energy spectrum of solar protons in the energy range 0.5–6.0 Mev was investigated. A semiconductor-detector was used in the spectrometer. The proton flux with energies above 2 Mev was insignificant. At a height of 120 km above the ground the number of protons with energies above 1 Mev was 450 ± 70 protons/cm^{2}sr.s. The integral spectrum of the protons at this height may in the energy range around 1 Mev be expressed as $N(>E) = 450\ E^{-5.5}$ protons/cm^{2}sr.s. (auth)

14708 RARE EARTHS IN OCEANIC BASALTS. Fred A. Frey and Larry Haskin (Univ. of Wisconsin, Madison). J. Geophys. Res., 69: 775-80(Feb. 15, 1964).

Rare-earth relative abundance distribution patterns barely altered from that characteristic of chondritic meteorites have been found in three basalts from the mid-Atlantic ridge and in one from the experimental Mohole. Lanthanum has been depleted to about half its normal chondritic relative abundance in all four specimens, and Ce and Pr have been depleted by 10 to 15 per cent in the ridge basalts. Absolute rare-earth concentrations are 10 to 16 times those of chondritic meteorites and are comparable to those of calcium-rich achondrites. It is probable that the whole-earth lanthanide distribution is identical with the chondritic pattern. The presence of this pattern in terrestrial, chondritic, and achondritic matter is chemical evidence in support of the hypothesis that bodies in the solar system derived from a homogeneous source. No time or mechanism for rare-earth enrichment of the basalts or of the calcium-rich achondrites over chondritic matter is indicated, but mechanisms that would fractionate the rare-earth group may be ruled out. (auth)

14709 DOPPLER COEFFICIENT MEASUREMENTS FOR U^{238} IN FAST-REACTOR SPECTRA. G. J. Fisher, H. H. Hummel, J. R. Folkrod, and D. A. Meneley (Argonne National Lab., Ill.). Nucl. Sci. Eng., 18: 290-2(Feb. 1964).

Experimental results of measurements of the Doppler temperature coefficient of reactivity of U^{238} for fast-spectrum assemblies on the ZPR III are reported. (R.E.U.)

14710 THE SPECTRUM OF THE SOLAR CORONA. M. J. Seaton (University Coll., London). Planetary Space Sci., 12: 55-74(Jan. 1964).

The interpretation of coronal observations in x-ray, ultraviolet, visible, and radio wavelengths is discussed. (auth)

14711 EFFECTS OF THE MAGNETIC FIELD ON THE IONIZATION FRONT. Yoriko Abe, Shirō Sakashita, and Yōrō Ōno (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 30: 816-26(Dec. 1963).

The effects of an interstellar magnetic field on the expanding HII region are investigated based on the simplified plane similarity solution. The conditions for the occurrence of M-type fronts are modified by the influence of the magnetic field. It is conjectured that the apparent form of the expanding HII region becomes not entirely circular but elliptic, elongated along the magnetic lines of force. From the observed ellipticity of the HII region, the intensity of interstellar magnetic field is estimated as $10^{-5} \sim 10^{-6}$ gauss. The efficiency of acceleration of interstellar clouds by the Oort-Spitzer mechanism is also discussed briefly. (auth)

14712 THE CHALLENGE OF CHROMOSPHERIC PHYSICS. R. Grant Athay (Univ. of Utah, Salt Lake City). Science, 143: 1129-38(Mar. 13, 1964).

A review is presented on theories and developments in the field of chromospheric physics. Chromospheric geometry, velocity fields, magnetic fields, thermodynamic equilibrium, thermodynamic structure, and chromospheric activity and space environment are discussed. (P.C.H.)

14713 LEPTONS, A MEDIUM FOR ENERGY TRANSMISSION. H. C. Dudley (Univ. of Southern Mississippi, Hattiesburg). 4p. (CONF-417-17)

From American Physical Society Division of Fluid Dynamics, Cambridge, Mass., Nov. 1963.

A new interpretation of previously published data, drawn from both subnuclear and astrophysics, is presented. Leptons are defined as a family of particles having finite mass less than 210 e_m, and include the neutrino-antineutrino group. Neutrinos of mass of the order 2×10^{-3} e_m exist as a generalized flux 7×10^{10}/cm^2/sec, their source being stellar and interstellar nuclear processes. Recent astrophysical observations indicate that the solar system consists of interlocking gravitational, electric, and magnetic fields, and the sun to be a (–) charged body generating an electric field such that the earth's orbit is a potential of 3×10^{17} volts (+) with respect to the sun. Under these conditions a flux of uncharged magnetic dipoles in random motion (neutrinos) would provide a medium for transmitting the energy of a charged oscillator, an electromagnetic wave. The wave velocity would not be a constant, but a function of flux concentration, electric and magnetic field strengths. The pathway of light in space would not necessarily be linear, nor on a Riemannian curve, as electromagnetic radiation would be refracted by variations of flux concentration or changes in any field gradient. (auth)

Atomic Physics

14714 (AD-411482) MOMENTUM OF ELECTRONS IN SOLIDS. Final Report, September 1, 1960 to June 30, 1963. K. Alexopoulos (Athens. Univ.). Contract DA-ERO-591-3-0003. 8p.

X-ray scattering on bound electrons in Cr_2O_3 was investigated. The velocity distribution of the bound electrons can be determined from the profile of the Compton spectrum. Measurements were carried out at angles of 10, 18, 32, and 45°. The resulting spectra are presented with the peak position of the Compton and Rayleigh lines indicated. (C.E.S.)

14715 (AD-430105) MEASUREMENTS OF CHARGE TRANSFER AND IONIZATION CROSS SECTIONS. Technical Report No. 18. James F. Nolan (Pittsburgh. Univ.). Dec. 1963. Contract Nonr 624(06). 55p.

Charge transfer and ionization cross sections were determined for protons and hydrogen atoms incident on molecular hydrogen. (C.E.S.)

14716 (AFCRL-63-225) SPECTROSCOPIC STUDIES WITH ION BEAMS. R. H. Hughes, J. L. Philpot, J. G. Dodd, and S. Lin (Arkansas. Univ., Fayetteville). Sept. 1962. Contract AF19(604)-4966. 23p. (AD-401058)

A spectroscopic study of ion-atom and ion-molecule collision processes was performed. Absolute cross sections for excitation of principal visible features are presented for proton impact on He, H_2, and N_2 in the proton-energy range from 10 to 130 kev. Optical radiation was observed at an angle to the beam, allowing measurement of charge-changing cross sections for electron capture into certain excited states of hydrogen. Studies of 200-kev proton impact on He and N_2 are reviewed, together with some spectral features of 200-kev H^{3+}, 130–200 kev H^{2+} impact on H_2 and He. Calculated minimum-energy defects for several reactions are also included. (auth)

14717 (ANL-6769(p.7-19)) MOMENTS OF THE OSCILLATOR STRENGTH DISTRIBUTION AND SOME ASSOCIATED QUANTITIES FOR THE HYDROGEN ATOM. Mitio Inokuti (Argonne National Lab., Ill.).

A systematic tabulation of moments of oscillator strength distribution and some associated quantities are given for hydrogen. The dipole oscillator strength f_n associated with the transition from the ground state 0 to an excited n is defined by, $f_n = E_n M_n^2$, where E_n is the excitation energy of the state n measured in units of the rydberg energy R and M_n^2 is the square of the dimensionless dipole matrix element between the states 0 and n. (M.C.G.)

14718 (JEN-128-DQ/I-38) 2Θ VALUES FOR FIRST-ORDER X-RAY EMISSION LINES A GERMANIUM ANALYZING CRYSTAL (2d = 6,532 Å). J. Bermudez Polonio (Spain. Junta de Energia Nuclear, Madrid). 1963. 23p.

Values of 2Θ are tabulated for the first order x-ray emission lines of elements with $15 \leq Z \leq 93$. (D.C.W.)

14719 (LFEN-7) X RAYS PRODUCED BY BREMSSTRAHLUNG ON A THICK TARGET WITH 1-2 Mev ELECTRONS. DETERMINATION OF THE INTENSITY DISTRIBUTION AROUND THE VAN DE GRAAFF MACHINE OF THE L.F.E.N. Maria do Carmo Anta, Manuel Jose de Campos Costa, Rui Namorado Rosa, Candido Marciano de Silva, and Horacio Maggiolli Novais (Portugal. Junta de Energia Nuclear. Laboratorio de Fisica e Engenharia Nucleares, Sacavem). 1963. 30p.

The intensity distribution of the x radiation around the Van de Graaff machine when electrons accelerated to energies between 1 and 2 Mev are incident on a thick gold target was measured using a Fricke dosimeter. On the basis of these measurements, constant intensity curves in the target room were determined; and the fraction of this energy which is transformed into radiant energy available in the room, as well as the intensity of the bremsstrahlung produced in the target in the direction of the incident electron beam was calculated as a function of the initial energy of the electrons. The results lead to an empirical law for the intensity of the bremsstrahlung transmitted at zero degrees. This law is in accordance with the theoretical formula of Kramers. (auth)

14720 (NASA-TN-D-1720) ELECTRON–HYDROGEN PHASE SHIFTS JUST BELOW THE INELASTIC THRESHOLD. Aaron Temkin (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). May 1963. 8p. (N63-16291)

The singlet s-wave phase shifts for the scattering of electrons by atomic hydrogen just below the inelastic threshold (10.2 ev) are calculated using a recently developed nonadiabatic theory. Previous calculations of Burke, based on the much more restricted close-coupling approximation, yielded a resonance characterized by the phase shift going through π radians. This result is indicative of a bound state of the compound system near the energy 9.4 ev. It is argued on the basis of a previous calculation that this resonance must be distinct from another resonance near 10.1 ev. On this basis it is concluded that this partial cross section must exhibit two resonances below threshold. (auth)

14721 (RTD-TDR-63-3111) CALCULATION OF DIPOLE MATRIX ELEMENTS. Final Report. S. Borowitz and M. Vassell (Dewey (G. C.) and Co., Inc., New York). Feb. 1964. Contract AF29(601)-5342. 58p.

Dipole matrix elements for 7s–np transitions in cesium were calculated using model wave functions of an electron moving in a Thomas–Fermi ion core. The calculated values for the energy levels using this model are in error by approximately 9% for the 7s state and are somewhat greater for the p states. The dipole matrix elements calculated for this model are in error by about a factor of three. A variational principle was derived for off diagonal matrix elements of any operator. This principle provides no correction for this model and for the Hartree Model, but has application if simple trial wave functions are used. (auth)

14722 (TID-20233) TECHNICAL PROGRESS REPORT [ON PHOTOVOLTAIC EFFECT]. (Temple Univ., Philadelphia). Feb. 1964. Contract AT(30-1)-2775. 56p.

The open circuit photovoltages, produced by irradiation of anodized zirconium electrodes coated with thin metallic films, were investigated. At liquid nitrogen temperatures, unusually large photopotentials, of the order of 90 volts, were observed. It was found that these high photovoltages occur only if the electrode is kept at liquid nitrogen temperatures and at a pressure greater than 10^{-5} mm for several hours. It was found that the effect is independent of the nature of the semi-transparent metallic contact. The effect occurs only with light of wavelength less than 2500 Å, which corresponds to the absorption edge of the oxide. The short circuit photocurrents produced with anodized niobium electrodes was found to fit the equation $I_p = \alpha L^n$, where I_p is the photocurrent and L is the light intensity. α and n were found to vary with wave length in the region 2500–3500 Å. α was found to depend on the partial pressure of oxygen. The results were used to devise a tentative trapping and recombination scheme. The diffuse reflectance spectra of impurity doped zirconium oxide was measured. Several transition metal ions were incorporated into the lattice by a high temperature diffusion process. All the samples were examined by means of x-ray diffraction and chemical analysis. The ions introduced include manganese(IV), cobalt(II), copper(II), vanadium(V), iron(III), and nickel(II). (auth)

14723 (TID-20238) STUDY OF THOMAS-FERMI MODEL FOR GRAPHITE. Progress Report. George S. Handler (Tufts Univ., Medford, Mass.). Feb. 20, 1964. Contract AT(30-1)-2968. 12p.

The concept of a continuously variable set of continuous bases, developed for the H atom, was applied to several larger systems ($He(^3S)$, $He(^1S)$, $Be^{2+}(^1S)$, Be, and Ne) using

the idea of a self-consistent field. The accuracy was much better than that obtained by the Thomas-Fermi, Fermi-Amaldi, or Thomas-Fermi-Dirac theories. (D.C.W.)

14724 (TID-20298) ENERGY AND ANGULAR DISTRIBUTION OF ELECTRONS EJECTED FROM GASES BY PROTONS. Progress Report. Theodore Jorgensen, Jr., and Jorge C. Anderson (Nebraska. Univ., Lincoln). 1964. Contract AT(11-1)-35. 31p.

The differential cross sections for the production of secondary electrons at various energies and angles by protons incident at 50, 100, 150, and 200 kev on Ne, N, O, and Ar were measured. The differential cross sections were integrated with respect to angle and energy to obtain cross sections differential in energy and angle, respectively. Total cross sections were obtained by integration over both energy and angle. (D.C.W.)

14725 (TID-20303) THE STOPPING CROSS SECTIONS OF CARBON AND HYDROCARBON SOLIDS (thesis). Chester Arthur Sautter (Nebraska. Univ., Lincoln). Aug. 1963. Contract AT(11-1)-35. 163p.

The stopping cross sections for protons and helium ions were measured in carbon, polypropylene, $(C_3H_6)_n$, and polyvinyltoluene, $(C_9H_{10})_n$, in the 30- to 350-kev energy range. The proton measurements of Lorentz and Zimmerman on polyethylene, polystyrene, and a styrene-butadiene copolymer were repeated and refined for the energy interval of 170 to 350 kev. The standard deviations in the stopping cross sections obtained from smooth curves drawn through points of individual measurements vary between 1.7% and 4.3%. Where comparable, the stopping cross sections are in fairly good agreement with prior experimental work. The results were compared with theory and with determinations by other methods. (auth)

14726 (UCRL-10647) RANGE-ENERGY RELATIONS OF He^3 CALCULATED FOR SEVERAL ELEMENTS. Andre C. Demildt (California. Univ., Berkeley. Lawrence Radiation Lab.). Feb. 11, 1963. Contract W-7405-eng-48. 50p.

The range-energy relations and the rate-of-energy losses for He^3 particles in several elements were computed. The kinetic-energy range covered for the incident particles was from 2.5 to 100 Mev. Range-energy results are also included for CaF_2, S_iO_2, teflon, quartz, and mylar. (auth)

14727 (WERL-4) INTERACTION OF PHOTONS WITH ADSORBED GAS. Research Report 63-928-441-R1. W. J. Lange (Westinghouse Electric Corp. Research Labs., Pittsburgh). July 30, 1963. 19p. (CONF-434-1)

From Surface Physics Symposium, Pullman, Wash., May 1963.

The probability of photodesorption (the number of molecules desorbed per incident photon) was measured for CO on tungsten. This probability is approximately 10^{-8} provided that prior to CO adsorption the tungsten ribbon was cleaned by heating to approximately 2300°K. It is also found that in the latter stage of such adsorption, CO is very weakly bound. As a result of this weak bond, CO is thermally released in the case of high coverage for very small temperature changes near 25°C. (auth)

14728 CHARACTERISTIC ENERGY LOSSES OF ELECTRONS IN SOLIDS. O. Klemperer and J. P. G. Shepherd (Imperial Coll. of Science and Tech., London). Advan. Phys., 12: 355-90(Oct. 1963).

A survey is presented of techniques and instrumentation for studying electron energy loss spectra in solids. The interpretation of these spectra in terms of plasma theory is discussed. Mean free path concepts are described. The effects of the physical state of the specimen, and of its environment (i.e., pure material, alloy, compound, etc.) are analyzed. Reproducibility of results and the effects of angular dispersion are examined. 90 references. (T.F.H.)

14729 THE LATTICE DYNAMICS OF AN ANHARMONIC CRYSTAL. R. A. Cowley (Cambridge Univ., Eng.). Advan. Phys., 12: 421-80(Oct. 1963).

The theory of the physical properties of an anharmonic crystal is discussed by using the thermodynamic Green's functions for the phonons. A perturbation procedure is developed to obtain the Green's functions and it is shown that for some purposes a quasi-harmonic approximation is useful, in which the frequencies of the normal modes are those determined by infra-red or neutron spectrometry. The thermodynamic, elastic, dielectric, and scattering properties of an anharmonic crystal are discussed in terms of the Green's functions, and detailed expressions are given for the more important contributions. Detailed numerical calculations are presented of the thermal expansion, dielectric properties, and shapes of some of the inelastically scattered neutron groups, for sodium iodide and potassium bromide. The calculations, which give reasonable agreement with experiment, show that even at quite low temperatures, the lifetimes of some of the normal modes can be quite short. By using the quasi-harmonic approximation it is shown that the large temperature dependence of the normal modes in a ferroelectric crystal can be treated adequately. (auth)

14730 BOMBARDMENT OF TUNGSTEN WITH 20-kev HELIUM ATOMS IN A FIELD ION MICROSCOPE. M. K. Sinha and E. W. Mueller (Pennsylvania State Univ., University Park). J. Appl. Phys., 35: 1256-61(Apr. 1964).

Fast He atoms were shot into one side of the tungsten emitter tip of a field ion microscope, and the resulting damage to the surface, consisting of vacancies, interstitials, and their clusters, were observed in atomic resolution. About one-half of the number of atoms calculated to have received a displacement energy of 50 ev in the interior appear as surface defects. The surface integrates the damage by focusing collisions coming from as deep as 1000 Å. Stress enhanced mobility of subsurface interstitials is detectable at 21°K, and rapid thermal diffusion from the depth occurs at 90°K. (auth)

14731 VIBRONIC SELECTION RULES AT SPECIAL POINTS OF THE BRILLOUIN ZONE: Pr^{3+} IN $LaCl_3$. Robert A. Satten (Univ. of California, Los Angeles). J. Chem. Phys., 40: 1200-5(Mar. 1, 1964).

The method of obtaining vibronic selection rules is described for an isolated impurity rare earth or actinide-type ion in a rare earth or actinide salt for various symmetry points of the Brillouin zone. The method is applied to Pr^{3+} in $LaCl_3$ and the results used to further interpret the vibronic spectrum previously reported by others. It is shown that in addition to the region around $k = 0$, the region about the plane $k_z = 0$ is also probably the most important for the vibronic transitions. The points K and K′ are shown to lead to the same type of spectrum as the point at $K = 0$. (auth)

14732 Al^{27} QUADRUPOLE COUPLING IN SOLID $AlCl_3$. P. A. Casabella and N. C. Miller (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Chem. Phys., 40: 1363-8(Mar. 1, 1964).

The nuclear quadrupole coupling constant of Al^{27} in solid anhydrous $AlCl_3$ was found to be 472 ± 24 kc/sec with an electric field gradient asymmetry parameter of zero. Assuming the crystal to be completely ionic,

the electric field gradient was calculated for the layered $AlCl_3$ structure by summing the contributions of the near ions, and treating the rest of the crystal as being made up of uniformly charged planes. This calculation gives an Al^{27} quadrupole coupling constant of −2.78 Mc/sec and an electric field gradient asymmetry parameter of zero. The addition of some covalent bonding tends to reduce the magnitude of the coupling constant and bring it into better agreement with the experimental value. It is estimated that the crystal is two-thirds ionic and one-third covalent. (auth)

14733 TRAPPING OF THE MOLECULAR EXCITON COUPLED WITH THE NUCLEAR VIBRATIONS. Andrzej Witkowski (Centre d'Etudes Nucleaires, Grenoble, France) and Antonio Quattropani. J. Chem. Phys., 40: 1453-4 (Mar. 1, 1964).

It is illustrated that the vibronic equation describing coupling of nuclear and electronic motions in dimers, in the simple model of two ethylenic molecules coupled by the exchange of the electronic excitation, can lead to the possibility of a new lowest exciton state of the total system with lower energy than energy of pure exciton state noninteracting with vibrations. (P.C.H.)

14734 LOW-LYING ENERGY LEVELS OF TRIVALENT CURIUM. B. G. Wybourne (Argonne National Lab., Ill.). J. Chem. Phys., 40: 1456-7(Mar. 1, 1964).

Low-lying energy levels for curium at $F_2 = 280$ cm^{-1} and $\zeta_{5f} = 2948$ were calculated. For the ground state, a magnetic splitting factor of $g = 1.932$ was calculated. (P.C.H.)

14735 ORBIT−ORBIT INTERACTIONS AND THE "LINEAR" THEORY OF CONFIGURATION INTERACTION. B. G. Wybourne (Argonne National Lab., Ill.). J. Chem. Phys., 40: 1457-8(Mar. 1, 1964).

From mathematical analysis, it was concluded that in least-squares analyses of the energy levels where the radial parts of correction terms are parametrized the effects of the orbit−orbit interactions will be simultaneously included and will screen the parameters associated with the linear theory of configuration interactions. Since the parameters deduced in least-squares analyses have the phases predicted by the linear theory of configuration interaction, it must also be concluded that the orbit−orbit interactions are of lesser importance than the effects of configuration interaction. (P.C.H.)

14736 TRANSITION PROBABILITIES OF FORBIDDEN LINES. R. H. Garstang (London Univ.). J. Res. Natl. Bur. Std., 68A: 61-73(Jan.-Feb. 1964).

Calculations of the transition probabilities of forbidden lines (magnetic dipole and electric quadrupole radiation) of laboratory and astrophysical interest are described. Results are given for Ti(III), Cr(II), Cr(IV), Mn(V), Mn(VI), Fe(VI), Fe(VII), Ni(I), Cu(II), Ga(I), Ge(I), Ge(II), As(I), As(III), Se(I), Br(I), Br(II), Kr(II), Kr(III), Rb(III), In(I), Sn(I), Sn(II), Sb(I), Sb(III), Te(I), I(I), I(II), Xe(II), Xe(III), Cs(III), Hg(II), Tl(I), Pb(I), Pb(II), Bi(I), Bi(II), Bi(III), Po(I), and Rn(II). (auth)

14737 SECOND AND THIRD VIRIAL COEFFICIENTS FOR HYDROGEN. R. D. Goodwin, D. E. Diller, H. M. Roder, and L. A. Weber (National Bureau of Standards, Boulder, Colo.). J. Res. Natl. Bur. Std., 68A: 121-6(Jan.-Feb. 1964).

Second and third virial coefficients for parahydrogen were derived from closely spaced PVT data from 24 to 100°K. They are in good agreement at 100°K with published data for normal hydrogen. Analytical representations of the combined data from about 20 to 423°K are presented and may be useful in computation of thermodynamic functions of the gas. The formulas are related to those resulting from the use of the Lennard-Jones potential. (auth)

14738 FORMATION OF NEGATIVE HELIUM IONS BY PASSAGE THROUGH INERT GASES. K. Melchior and A. Papkow. (Phys. Letters, 8: 178(Feb. 1, 1964). (In German)

The energy-dependent cross section for the formation of He^- from He^+ in argon, krypton, neon, and xenon was studied for energies (He^+) of 10 to 80 kev. (R.E.U.)

14739 NEW LINES OF MULTIPLY IONIZED OXYGEN AND NITROGEN. K. Bockasten, R. Hallin, K. B. Johansson, and P. Tsui (Uppsala Univ.). Phys. Letters, 8: 181-2 (Feb. 1, 1964).

Results are given for the strongest lines of OV, OIII, NVI, and NV. (R.E.U.)

14740 PHOTOIONIZATION CROSS SECTION OF NEON IN THE 80 TO 600 Å REGION. D. L. Ederer and D. H. Tomboulian (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 133: A1525-32(Mar. 16, 1964).

Measurements of the absolute photoionization cross section of neon in the soft x-ray region (80 to 600 Å) are presented to an accuracy of 5% or better. Increased reliability of measurements was brought about by various technical improvements such as the use of an absorber cell with suitable windows and the use of a Geiger-Mueller tube specially designed for counting photons whose energy was in excess of 40 ev. At the $L_{2,3}$ threshold(575 Å) the cross section σ has a value of 6.3 Mb, rises to a peak value of 10.0 Mb at 375 Å, and then decreases to 7.8 Mb at the L_1 edge (about 261 Å). The range of measurements was extended to 10 Ry above the ionization threshold. Consequently, it was possible to join the results with previous observations made at high energies. With the exception of He, neon is the only other gas for which the value of σ is known over a large energy range with sufficient precision. This information, combined with estimates of discrete oscillator strengths, has led to the first successful evaluation of the Thomas-Reiche-Kuhn sum rule. (auth)

14741 TRUNCATED MATCHING POTENTIALS IN THE CLASSICAL THEORY OF ELASTIC ATOMIC SCATTERING. Christian Lehmann and Mark T. Robinson (Oak Ridge National Lab., Tenn.). Phys. Rev., 134: A37-44(Apr. 6, 1964).

Atomic collisions in the radiation damage of solids can be described by repulsive potentials for which the scattering integrals cannot generally be evaluated in closed form. However, the evaluation becomes possible when the actual interatomic potential is replaced by certain truncated power potentials that match the actual potential in value and in slope at the minimum distance. The usefulness and accuracy of such matching potentials are discussed and numerical examples are given for the scattering angle, the "time integral," and the energy transfer in the cases of an exponential and of an exponentially screened Coulomb potential. The agreement with the exact numerical solutions is surprisingly good. (auth)

14742 ELECTRONIC g FACTORS OF THE p^3 CONFIGURATION IN Ge I and Sn I. W. J. Childs and L. S. Goodman (Argonne National Lab., Ill.). Phys. Rev., 134: A66-9(Apr. 6, 1964).

Electronic g factors were obtained by the atomic-beam magnetic-resonance technique for all $J \neq 0$ states arising from the p^3 electronic configuration in Ge I and Sn I. The results for the $^1D_2$, $^3P_2$, and $^3P_1$ states for Ge are 1.00639(8), 1.49458(9), 1.50111(7); and for Sn they are 1.05230(8),

1.44878(9), and 1.50110(7), respectively. The results are compared with intermediate-coupling calculations. (auth)

14743 ENERGY LOSSES AND ELASTIC RESONANCES IN ELECTRON SCATTERING FROM H_2. C. E. Kuyatt, S. R. Mielczarek, and J. Arol Simpson (National Bureau of Standards, Washington, D. C.). Phys. Rev. Letters, 12: 293-5(Mar. 16, 1964).

Techniques of high-resolution electron spectroscopy were used to study electron scattering from H_2. Inelastic scattering measurements show well-resolved vibrational levels of several electronic states in H_2, elastic measurements show at least eight narrow resonances in the cross section. (R.E.U.)

14744 RESONANT EXCITATION IN HELIUM ION–ATOM COLLISIONS. Nyle G. Utterback (Univ. of Denver). Phys. Rev. Letters, 12: 295-8(Mar. 16, 1964).

An energy resonance in the production of helium metastable atoms was observed for helium ions impacting on helium atoms. The peak of the resonance occurs at 28 ev in the c.m. system for metastables scattered forwardly. (R.E.U.)

14745 POSITRONIUM FORMATION BY FAST POSITRONS IN ATOMIC HYDROGEN. I. M. Cheshire (Glasgow Univ.). Proc. Phys. Soc. (London), 83: 227-37(Feb. 1964).

The cross sections for the formation of a positronium atom in the ground state by positrons in atomic hydrogen are calculated in the Born and impulse approximations in the energy range 10 ev to 500 ev. Although the total cross sections predicted by these approximations are similar at high energies, their angular distributions differ considerably. (auth)

14746 ON THE ELASTIC SCATTERING OF SLOW ELECTRONS BY HELIUM ATOMS. Tasuke Hashino and Hidehiko Matsuda (Kurume Technical Coll., Kyushu, Japan and Kyushu Univ., Fukuoka). Progr. Theoret. Phys. (Kyoto), 30: 918-19(Dec. 1963).

The elastic cross section for electron scattering by helium at zero energy was calculated using Kohn's variational method. (R.E.U.)

14747 SOME ENERGY CHARACTERISTICS OF ELECTRON PASSAGE THROUGH A SOLID. A. Ya. Vyatskin and A. N. Pilyankevich (Inst. for Exact Mechanics and Optics, Leningrad). Soviet Phys-Solid State (English Transl.), 5: 1662-7(Feb. 1964).

With the aid of the characteristics of the transmitted electrons the energy distribution of electrons leaving an intermediate layer of a solid film was investigated. The mechanism of energy distribution in any intermediate layer under conditions of multiple collision is explained. A new method is proposed for determining energy loss on the basis of the energy distribution and the distribution (dispersion) of the electron paths. The mean energy loss of the electron and the distribution of energy absorption are also discussed. (auth)

14748 EFFECTIVE COLLISION RADIUS IN EXPERIMENTS ON SPUTTERING AND ION-ELECTRON EMISSION OF SINGLE CRYSTALS. E. S. Mashkova and V. A. Molchanov (Moscow State Univ.). Soviet Phys.-Solid State (English Transl.), 5: 1736-7(Feb. 1964).

The effective collision radius and ion-electron emission coefficient are calculated for a copper target sputtered by 30-kev argon ions. (C.E.S.)

14749 PAIR CORRELATIONS OF ELECTRONS IN THE THEORY OF ATOMS. [PART] I. L. N. Labzovskii. Vestn. Lenningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 12-21(1963). (In Russian)

For describing the pair correlations of the electrons in the many-electron systems a new method of reducing the many-particle problem to the two-particle problem is developed. Instead of the wave function, one- and two-particle density matrices are used. In the process of deriving an equation for the two-particle wave function, which describes a pair of electrons in the field of the others, a transition to the second quantization representation is accomplished. The solution of the obtained equation is carried out with the help of perturbation theory. (auth)

14750 CALCULATION OF THE CORRELATION ENERGY OF MANY-ELECTRON SYSTEMS BY THE VARIATIONAL METHOD. L. N. Labzovskii. Vestn. Lenningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 127-30(1963). (In Russian)

The method of calculating pair correlation energies of the electrons in the many-electron systems is suggested. The method is based on a variational principle. The calculation of the correlation energies of 1s–1s and 1s–2s pairs in the lithium atom is given as an example. (auth)

14751 VON KARMAN MODEL THEORY OF LATTICE THERMAL CONDUCTIVITY. John H. Henkel (Univ. of Georgia, Athens) and George S. Dixon. Pt. II, p.134-48 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N. C., University of North Carolina, 1963.

The simple von Karman model of thermal conduction is extended to include anharmonic terms in the potential energy expression and is applied to isotropically conducting crystals. The crystal is divided into cells containing N atoms each. Normal modes for harmonic oscillations of the N atoms in each cell are determined under the conditions that all the other atoms in all the other cells are at rest at their mean positions. The potential energy is then expanded up to the fourth degree in the normal mode amplitudes. For simplicity of presentation, only first order perturbation is used. Fourth degree terms are used to shift the energy levels and to broaden them while second degree terms, bilinear in the normal mode amplitudes for different cells, are used to induce energy transfers. Results of calculations for a one-dimensional model are presented. (auth)

14752 ORTHO-PARA TRANSITION IN MOLECULAR HYDROGEN. J. C. Raich and R. H. Good, Jr. (Ames Lab., Ames, Iowa). p.295-7 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963. (IS-758)

An estimate of the probability for the ortho-para transition in molecular hydrogen is presented. (C.E.S.)

14753 RESEARCH ON THRUST FROM NEUTRAL ATOM EJECTIONS FROM SOLIDS. Ben B. Meckel (Physics Tech. Labs., Inc., La Mesa, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Preprint 64-10, 7p, $1.00. (CONF-392-4)

From Aerospace Sciences Meeting, New York, Jan. 1964.

The process of controlled induced sputtering to generate a high-velocity preferentially ejected atomic beam for application in space propulsion systems is described. Parameters and complex mechanisms, which can be utilized to enhance the energy conversion method, are described. Results of initial investigations on force and mass flow studies are discussed, and some basic design aspects are mentioned. (R.E.U.)

14754 CONTINUUM EMISSION COEFFICIENTS FROM THE QUANTUM DEFECT METHOD. A. D. Anderson (Naval Research Lab., Washington, D. C.) and H. R. Griem. 19p. (CONF-13-11)

From American Physical Society 1963 Southwestern Meeting, Houston, Tex., Feb. 1963.

Coefficients for the contribution of radiative recombination into low-lying excited states of neutral helium, carbon, nitrogen, and oxygen are estimated using a modified calculation of photo-ionization cross sections. For the lower principal and orbital quantum number levels of hydrogen, the revisions serve to improve the agreement with exact results. For higher hydrogen levels, no satisfactory agreement can be achieved. Since the corresponding levels in other light atoms are often quite hydrogenic, their contribution is therefore probably described more accurately by the hydrogen formula rather than by the results of the quantum defect method. (auth)

Cosmic Radiation

14755 (AD-401660) SUMMARY OF PRESENT KNOWLEDGE ON SPACE RADIATION. A. D. Goedeke (Douglas Aircraft Co., Inc., Santa Monica, Calif.). Feb. 1963. 54p. (CONF-394-1)

From 1963 National Winter Convention on Military Electronics, Los Angeles, Feb. 1963.

The present knowledge of the nature and properties of interplanetary plasma and galactic, solar, and trapped radiations is summarized. Particular emphasis is placed upon solar cosmic radiation, solar flares, solar-terrestrial relations, and time variations. Results of analyses of various events is described in light of biological dose restrictions. Present research programs on prediction of solar cosmic rays and their time variations are also discussed. (auth)

14756 (ANL-6769(p.34-9)) MEASUREMENT OF THE COSMIC-RAY NEUTRON BACKGROUND. Jacob Kastner, B. G. Oltman, and L. D. Marinelli (Argonne National Lab., Ill.).

Measurements are being made of the cosmic neutron background using a twin-scintillator fast neutron spectrometer. Xylene and hexafluorobenzene are used as the scintillator solutions. Each of the solutions is viewed by a pair of photomultipliers operated in coincidence. Two different electronic circuits were designed to discriminate between neutron- and gamma-produced scintillations. Calibration of pulse height vs. electron energy was carried out using Co^{60}, Cs^{137}, and Zn^{65} gamma rays for their Compton interaction. (M.C.G.)

14757 (N63-19946) GEOMAGNETIC IMPLICATIONS OF THE COSMIC-RAY DIURNAL VARIATION AND ITS SPECTRUM. Final Project Report. Donald E. Cotten (New York Univ., New York. Coll. of Engineering). Mar. 1, 1963. Contract DA-36-039-SC-87171. 119p.

Contours are presented showing the cosmic-ray diurnal variation (CRDV) amplitude and phase, and the amplitude of the semidiurnal variation, as functions of latitude and longitude. These maps display relative extremes that correspond to extremes of geomagnetic field maps and indicate that the geomagnetic dipole and quadrupole moments, as measured at the earth's surface, significantly affect the anisotropic part of the cosmic radiation. An explanation is given for the fact that the semidiurnal variation has appreciable amplitude only along part of the magnetic equator. The cosmic-ray anisotropy introduced by the solar system is found to come from a direction 75 to 100° east of the sun. Small CRDV components dependent on Greenwich time and sidereal time are discussed. 100 references. (auth)

14758 DIFFERENT REPRESENTATION FORMS OF THE NUCLEONIC COMPONENT IN COSMIC RADIATION. Terje Svanes (Univ. of Bergen, Oslo). Arbok Univ., Bergen, Mat.-Nat. Ser., No. 12, 11p.(1962).

In order to investigate the remarkable intensity variations such as decrease, increase, and latitude effects the pressure correction of the nucleonic component in the secondary cosmic radiation ought to be the correction in the logarithmic representation. If the natural logarithm of the counting rate is used, it is not necessary to worry about the standard for the reduction of the relative intensity. Moreover, the barometer correction becomes much more accurate than the linear approximation and the second-order approximation, because the secondary cosmic ray intensity is a roughly exponential function of the barometric pressure. A direct comparison between these three representations is obtained on the basis of an experimental analysis with data from periods in 1959 and 1960. (auth)

14759 COSMIC-RAY INTENSITY AT THULE, GREENLAND, DURING 1962 AND 1963 AND A COMPARISON WITH DATA FROM MARINER 2. H. V. Neher and H. R. Anderson (California Inst. of Tech., Pasadena). J. Geophys. Res., 69: 807-14(Mar. 1, 1964).

During each of the summers of 1962 and 1963 six balloon flights were made at Thule, Greenland (geomagnetic latitude 88°N), in continuation of a program to follow the secular changes in primary cosmic rays. Similar flights at Thule were made during most of the years beginning in 1951. The flights usually extended over a period of at least two weeks to be sure that transient effects were minimized. Following the substantial increase from 1961 to 1962 of 20 per cent at high altitudes, a much smaller increase of 7.5 per cent occurred between 1962 and 1963. Three weeks after the last flight at Thule in 1962, data had started to be received from the Venus probe Mariner 2. This vehicle had aboard an ionization chamber that was compared with the balloon-borne chambers, both with γ rays and with cosmic rays at high altitudes. From a comparison of the data from the two instruments a value of 21 per cent is derived for the albedo effect at the top of the atmosphere at Thule. (auth)

14760 OBSERVATIONS OF PRIMARY COSMIC-RAY VARIATIONS USING ION CHAMBER AND GEIGER COUNTERS. 1. A COMPARISON OF THE LONG-TERM AND FORBUSH VARIATIONS. N. Nerurkar and W. R. Webber (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 69: 815-30(Mar. 1, 1964).

Measurements of cosmic-ray intensity made by an ion chamber and a Geiger counter on balloon flights over Minneapolis during 1959-1963 are presented. The cosmic-ray intensity is shown to be uniquely related to the neutron monitor rate at high latitudes and at the equator. Of particular interest are the solar-cycle modulation and the individual Forbush decreases, seven of which were registered at different levels of the cosmic-ray intensity. It is found that the effects of the two modulations, when studied over identical levels of cosmic-ray intensity, are identical within the accuracy of the method of comparison. (auth)

14761 FAST NEUTRONS IN THE EARTH'S ATMOSPHERE. 1. VARIATION WITH DEPTH. Robert C. Haymes (California Inst. of Tech., Pasadena). J. Geophys. Res., 69: 841-52(Mar. 1, 1964).

A series of balloon flights at $\lambda = 41°N$ to atmospheric depths of about 3.6 g/cm^2 were conducted in 1963. A phoswich type of scintillation counter, which has a high efficiency for neutrons in the 1- to 14-Mev range, was employed. Gamma rays and charged particles are distinguished through pulse-shape discrimination and are separately telemetered. The experiments revealed that the mean free path for absorption in the lower atmosphere was 169 ± 13 g/cm^2, and that the neutron flux at the 90-g/cm^2 transition maximum was 1.1 neutrons/cm^2 sec. The flux at the highest altitudes attained was 0.39 n/cm^2 sec, and an extrapolation to the top of the atmosphere that follows Newkirk's theory yields 0.24 ± 0.02 n/cm^2 sec for the neutron flux at the boundary. The absolute values are accurate to ±20 per cent. The flux as a function of depth is in good agreement with the calculations of Newkirk and of Lingenfelter. It is in disagreement with the original calculations of Hess, Canfield, and Lingenfelter. The extrapolated flux is lower than the fluxes measured by others in satellite experiments. The experimental discrepancy may be caused by local production effects in the satellites. A featureless differential energy spectrum with an $E^{-1.3\pm.1}$ dependence was measured. (auth)

14762 FAST NEUTRONS IN THE EARTH'S ATMOSPHERE. 2. TIME VARIATIONS AT HIGH ALTITUDES. Robert C. Haymes (California Inst. of Tech., Pasadena). J. Geophys. Res., 69: 853-9(Mar. 1, 1964).

A series of balloon flights launched during 1963 at $\lambda = 41°N$ are analyzed. The balloons carried omnidirectional detectors sensitive to fast neutrons and (separately) γ rays to altitudes of about 125,000 feet for periods of up to 24 hours. The observed latitude dependence is in accordance with the theory of Lingenfelter. The observed day-to-night ratios of the fluxes were 1.01 ± 0.02 and 1.00 ± 0.01. An upper limit of 0.02 neutron/cm^2 sec for the solar flux at the earth can be determined if it is assumed that the solar spectrum is similar to the terrestrial spectrum. The explanation for the small fluctuations that were observed probably lies in a slight time variation of the intensity of the charged radiation incident on the top of the earth's atmosphere. No evidence was found for γ rays (energies between 0.47 and 3.50 Mev) emanating from the sun or from the Crab Nebula. (auth)

14763 NATURE OF SOURCES OF COSMIC SYNCHROTRON RADIATION. Joseph Shklovskii (Univ. of Moscow). Nature, 201: 588(Feb. 8, 1964).

An analogy is made between the emission from radio stars and the synchrotron radiation from supernovas in a period of maximum brightness. (R.E.U.)

14764 THE FIRST POSITRONS FROM SPACE. Peter Stubbs. New Scientist, 21: 140(Jan. 16, 1964).

The sources of cosmic electrons are discussed. An experiment is reviewed in which the ratio of positron to negatrons was determined in balloon flight. (R.E.U.)

14765 MEASUREMENT OF LOW-ENERGY COSMIC-RAY PROTONS. Karl A. Brunstein (Univ. of California, Berkeley). Phys. Rev., 133: B1520-5(Mar. 23, 1964).

The results of a high-altitude balloon measurement of the primary-proton spectrum at energies between 57 and 77 Mev are reported. It is concluded that the primary flux of these low-energy protons at Churchill, Manitoba is negligible, both as compared to the atmospheric secondary contribution and as compared to the primary flux at higher (~1 Bev) energies. A statistical upper limit of $dJ/dE < 0.49$ protons/m^2-sr-sec-Mev at $E \cong 67$ Mev is obtained. (auth)

14766 MAGNETOSPHERIC CUTOFF FOR 1.5-Mev EXTRATERRESTRIAL PROTONS. C. Y. Fan, J. A. Simpson, and Edward C. Stone (Univ. of Chicago). Phys. Rev. Letters, 12: 269-71(Mar. 16, 1964).

Results are reported of satellite measurements of the 1.5-Mev proton flux over the geomagnetic polar regions during periods of low geomagnetic activity. (R.E.U.)

14767 NEUTRON PRODUCTION BY COSMIC RAY PROTONS IN LEAD. E. B. Hughes (Univ. of Leeds, Eng.), P. L. Marsden, G. Brooke, M. A. Meyer, and A. W. Wolfendale. Proc. Phys. Soc. (London), 83: 239-51(Feb. 1964).

The production of evaporation neutrons in the interactions of cosmic protons with lead nuclei was studied. For the thick target used the mean number of neutrons produced (the mean 'multiplicity') increases from 10 to 100 over the energy range from 0.2 to 200 Bev. At low energies, less than 0.5 Bev, there is good agreement with the mean multiplicities computed by Metroplis, but, as the energy increases, the observed multiplicities fall increasingly below expectation. At the highest energies, greater than or equal 10 Bev, there is evidence for a flattening of the multiplicity variation, and the results are not inconsistent with a variation of the form expected from the Heisenberg model of the N-N interaction. (auth)

14768 THE PRODUCTION OF NEUTRONS BY FAST COSMIC RAY MUONS. M. A. Meyer (Univ. of Durham, Eng.), A. W. Wolfendale, E. B. Hughes, and P. L. Marsden. Proc. Phys. Soc. (London), 83: 253-8(Feb. 1964).

The production of evaporation neutrons in the reactions of fast mesons(μ^-) in lead was studied. The measured value of the product of the cross section per atom and mean neutron multiplicity divided by A, $\sigma\bar{\nu}/A$, is found to increase from 10 to 200×10^{-29} cm^2 per nucleon, over the muon momentum range from 1 to 100 Bev/c. The measured values of $\sigma\bar{\nu}/A$ are close to those expected on the basis of the Williams–Weizsacker treatment as given by Heitler. It is concluded that there is no evidence for any marked anomaly in the behavior of the muon in interactions in which neutrons are produced. (auth)

14769 COSMIC-RAY ENERGY SPECTRUM AND HIGH-ENERGY PARTICLES IN SUPERNOVA. Humitaka Satô (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 30: 804-15 (Dec. 1963).

The cosmic-ray energy spectrum is obtained in the form of a power law by assuming an equipartition of source energy among the magnetic field, turbulence, and high-energy particles in the cosmic-ray source for the case where the volume of the source is changing with time. Studies were made of a model that is suited to the mechanism: The energy distribution in the source is sharp for protons and broad for electrons. The sharp one is due to the fact that the injection in the accelerating region is dominant only in the initial stage at the supernova explosion. The secondary electrons from protons give rise to a luminosity maximum at the explosion by synchrotron mechanism. (auth)

14770 STUDY OF DISTRIBUTION OF TRANSVERSAL MOMENTA OF STRANGE PARTICLES. N. N. Roinishvili. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 9: 3-51(1963). (In Russian)

The distribution of transversal momentum of strange particles generated in penetrating cosmic showers is given. The obtained distribution is analyzed from the point of view of one and three-dimensional variants of the theory of Landau and of the theory of Heisenberg. (auth)

14771 FLUCTUATIONS IN EXTENSIVE AIR SHOWERS. E. V. Gedalin. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 9: 55-66(1963). (In Russian)

There is considered a method of calculation of the probability of the fact that a shower generated by a particle of the definite kind at the given depth t will have the definite characteristics (the numbers of the particles of different kinds, the fluxes of energy of different components of EAS etc). It is shown that the iterative solution of common integral equations of a cascade process leads to a simple diagram technique, when one can easily formulate the rules of probability calculation for the given picture of the shower. The method is quite general and can be used for any branching process with an arbitrary model of an elementary act. (auth)

14772 ACCELERATION OF CHARGED PARTICLES BY VARIABLE MAGNETIC FIELDS. V. A. Ankudinov, V. M. Kel'man, and L. N. Sysoeva. Zh. Tekhn. Fiz., 34: 23-33(Jan. 1964). (In Russian)

It is shown that the energy of a charged particle moving in a variable magnetic field is not constant through the field variations. The origin of cosmic rays was analyzed on the basis of such a phenomenon. (R.V.J.)

14773 ELEMENTARY PARTICLES AND COSMIC RAYS. Alladi Ramakrishnan. A Pergamon Press Book. New York, The Macmillan Company, 1962. 580p. $15.00.

Elementary particles are investigated with emphasis on: single-particle wave functions and wave equations; quantum electrodynamics; pion physics; non-perturbative approach to quantum field theory; strange particles and their interactions; weak interactions; strong interactions and strange particles; and symmetries and strong interactions. Cosmic radiation is reviewed, with emphasis on: primary cosmic radiation; geomagnetic effects; interactions of cosmic rays with matter; cascade processes; and the origin of cosmic radiation. (T.F.H.)

14774 CORRELATED NEUTRONS IN A SIMPSON PILE. B. Meyer. Thesis, Munich, Universitlt, Munich, 1962. 56p. $2.00(Gmelin, AED-DISS. 62-620). (In German)

The correlation of evaporation neutrons was studied by measurements of the low-energy nucleon component of cosmic radiation using 2 standard Simpson piles at 2 different locations. Groups with an average of 1.25 and 1.30 neutrons were observed. The accuracy of the results as a function of electronic dead-time is discussed. A reduction of relative standard deviation by lengthening of the dead-time, which should be of the order of the diffusion time, is proposed. (Gmelin Inst.)

Criticality Studies

14775 (AHSB(S)R-68) THE POSSIBILITY OF AN AUTO-CATALYTIC CRITICALITY EXCURSION IN AN ARRAY OF FISSILE UNITS. E. R. Woodcock (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, Risley, Lancs, England). 1964. 15p.

The changes in reactivity of arrays of fissile units as the individual units expand were studied numerically. The energy yield resulting from a criticality excursion in an array of fissile units was greater than that resulting from a single unit starting with the same excess reactivity. A hazardous situation may arise if the units in the array are individually enclosed in separate cells. In this case there is a possibility of an autocatalytic reaction in which the reactivity initially increases. It is possible in certain circumstances for a system initially below prompt critical to build up to a super-prompt-critical state before the reaction starts to subside. (auth)

Direct Energy Conversion

14776 (CONF-414-1) THE LIQUID METAL LINEAR GENERATOR. E. S. Sowa (Argonne National Lab., Ill.). Oct. 31, 1963. Contract W-31-109-eng-38. 13p.

From Conference on Direct Energy Conversion, Argonne, Ill., Nov. 1963.

In the utilization of nuclear heat energy, liquid metal could be used in a vapor cycle to propel a column of liquid metal in a jet pump or injector where electrical energy could be extracted by means of a MHD arrangement. The recirculating system is being studied as a means of increasing the efficiency. Results are described briefly for a preliminary run made using steam and water; the efficiency of conversion of steam kinetic energy to liquid kinetic energy was ~20%. The possible causes of the low efficiency and some of the methods for decreasing hydraulic losses are outlined. (D.L.C.)

14777 (CONF-414-2) WHY STUDY DIRECT CONVERSION? Bernard I. Spinrad (Argonne National Lab., Ill.). Sept. 1963. Contract [W-31-109-eng-38]. 22p.

The bases of the interest in development of new energy conversion processes are discussed. Conservation of energy resources, efficiency of present and new energy conversion processes, and the demands of space exploration are considered. (D.C.W.)

14778 (GA-4071) THERMIONIC SPACE POWER REACTOR SYSTEM RESEARCH AND DEVELOPMENT. Annual Summary Report, May 1, 1962–April 30, 1963. N. B. Elsner, J. W. Holland, R. W. Pidd, J. T. Ream, Jr., W. B. Wright, and L. Yang (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Dec. 17, 1963. Contract AT(04-3)-167. 113p.

Activities in a program to test and develop prototype fission-heated thermionic cells for space uses are reported. During the period, in-reactor tests were conducted on two W-clad U-bearing fuel emitters and one unclad type. Fuel emitter proof tests were also conducted which demonstrated 1000-hr operational capability of W-clad systems. Output power density and the temperature of heat rejection were found to have major effects on the weight-performance characteristics of the system. Advances in techniques related to W vapor deposition are reported. Descriptions of the fuel-emitter development, cell design and development, and testing of out-of-pile and in-pile cells are included. Operation of the clad-type test cells at design power and temperature led to selection of these cells for planned long-duration in-pile tests. (J.R.D.)

14779 (GA-4729) PERFORMANCE AND ENERGY-TRANSFER MEASUREMENTS ON CYLINDRICAL CESIUM THERMIONIC CONVERTERS. J. W. Holland (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nov. 13, 1963. Contract AT(04-3)-167. 60p.

Detailed measurements of performance and energy transfer were made on two highly instrumented cylindrical cesium thermionic converters with electrically heated tungsten emitters. The first converter, OC-4, which had a niobium collector, operated with an initial electrical output of 6.9 watts/cm^2. This output gradually degraded to a value of 4.6 watts/cm^2 after 1351 hr. These power values were measured at the electrodes for an average emitter temperature of 1750°C. Converter OC-5, which had a molyb-

denum collector, has operated 260 hr to date, with a power output and efficiency of 11.1 watts/cm^2 and 16%, respectively, at an average emitter temperature of 1800°C. These operating data are compared with those for lower emitter temperatures below.

Emitter Temperature (°C)	Power Density (watts/cm^2)	Efficiency (%)
1800	11.1	16
1600	7.5	12
1400	4.2	8.4
1200	1.0	4.9

Energy values of the emitter electron cooling, collector electron heating, thermal radiation, and cesium conduction were calorimetrically determined as a function of emitter temperature, collector temperature, cesium pressure, and current. For all the data obtained, the emitter temperature profile was measured by thermocouples. From the calorimeter measurements, correlations were found for the prediction of emitter electron cooling ΔQ_E and collector electron heating ΔQ_C: $\Delta Q_E = I\,(2.6 + V)$, and $\Delta Q_C = I\,(2.6)$. The correlation is valid within 4% accuracy over the operating variable range: emitter temperature of 1200 to 1800°C; cesium reservoir temperature of 300 to 400°C; collector temperature of 600 to 700°C; and current of zero to 15 amp/cm^2. Through measurements of emitter-structure heat losses, of the cesium-vapor thermal conduction, and of the electrode radiation heat transfer, it was found that all the zero-current energy-transfer quantities can be accurately predicted with RAT, a two-dimensional digital-computer heat-transfer code. The electron cooling correlation, together with the ability to calculate all of the power-loss values in a thermionic converter, makes it possible to compute the efficiency of a converter when the I-V characteristics and materials properties are known. This is of special interest to thermionic reactor analysis, since the input to the reactor problem is the amount of fission produced in each of a very large number of cells within the reactor. Apart from the utility of the correlation discovered, the determination of the value of 2.6 volts in the current-heating terms is of fundamental interest and invites further study. (auth)

14780 (GEST-2025(Rev.1)) RESEARCH PROGRAM FOR THE LONG TERM TESTING OF CYLINDRICAL DIODES AND THE RADIATION OF FUEL AND INSULATOR. Quarterly Progress Report, June 18, 1963–September 17, 1963. (General Electric Co. Vallecitos Lab., Pleasanton, Calif.). Contract NAS 3-2544. 45p.

A program to provide direct evidence of thermionic converter life dependence on variables of spacing and operating temperatures, using configurations representative of anticipated thermionic fuel element designs, is described. Plans for a basic test device consisting of a thermionic converter using cylindrical emitter-collector geometry are discussed. Work toward fabrication and assembly of three identical converters during the period is reported. Other work is reported on plans for Cs irradiation and environmental testing of UO_2 clad with W–26% Re alloy. Vacuum environmental testing of UO_2–W dispersions clad with W–26% Re alloy is also planned. Physics calculations concerning the use of UO_2–W dispersions in thermionic reactors were initiated. A summary of core data for a 5-Mw(e) system at 10 w/cm^2 is included. Plans for irradiation of encapsulated alumina insulator specimens at 1000 to 1200°C are discussed. (J.R.D.)

14781 (IDA/HQ-63-1412(Vol.I)(p.125-31)) HIGH-POWER SHORT-DURATION MHD POWERPLANTS. Stuart Hamilton (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.).

An MHD generator capable of supplying large amounts of power on instant demand was studied. The flow and material requirements for optimization of the power density were determined, and suitable materials were developed. 800 kw/ft^3 has been generated with a magnetic field of only 21,000 gauss. This power density has been maintained for 1.5 hr. The cost of a 1000 Mw generator was estimated to be 10^7 dollars with an operating cost <10¢/kw-hr. (D.C.W.)

14782 (IDA/HQ-63-1412(Vol.I)(p.132-64)) VERY HIGH-POWER, LIMITED DUTY-CYCLE, ROCKET-DRIVEN MHD GENERATORS. Arthur Kantrowitz and Thomas Brogan (Avco Corp. Avco-Everett Research Lab., Everett, Mass.).

Magnetohydrodynamic generators using the heat release of rocket engines to supply high power outputs were investigated. The cost of a 10,000 Mw unit was estimated to be about $3/kw, using Saturn F-1 engines. A 20-Mw generator was scheduled to operate for three minutes in the fall of 1963. (D.C.W.)

14783 (IDA/HQ-63-1412(Vol.I)(p.165-70)) EXPLOSIVE (XMHD) GENERATORS FOR ULTRA-HIGH-POWER PULSES. Arthur T. Biehl (Aerojet-General Nucleonics, San Ramon, Calif.).

The conversion of high-explosive energy to electrical energy by the performance of work on a magnetic field was studied. The theory of XMHD generators as applied to driving flash lamps and other electrical loads has been developed and experimentally confirmed. The requirements, size, hazards, and costs of large generators are indicated. (D.C.W.)

14784 (IDA/HQ-63-1412(Vol.I)(p.171-3)) GENERATION OF ELECTRIC POWER FROM EXPLOSIVES. V. H. Blackman, M. S. Jones, and C. N. McKinnon (MHD Research, Inc., Newport Beach, Calif.).

Peak electrical powers of 1.8 Mw/in.^{3} were obtained by MHD principles from a seeded 10-gr charge of condensed explosive. This corresponds to 10^{11} w/m^3 of channel volume. With a generator volume of 5×10^3 m^3, a total energy output of 10^{10} joules/10^{-3}-sec pulse seems realizable. Preliminary studies also indicate that nuclear explosion-driven, linear MHD generators are feasible and could deliver $\gg 10^{10}$ watts for times on the order of minutes. (D.C.W.)

14785 (NASA-CR-54009) VAPOR-FILLED THERMIONIC CONVERTERS. Final Report. K. G. Hernqvist, J. R. Fendley, H. Hendel, and J. D. Levine (Radio Corp. of America. RCA Labs., Princeton, N. J.). Dec. 1963. Contract NAS 3-2531. 53p.

First, electron emission S-curves are computer-calculated by means of the Levine-Gyftopoulos adsorption theory, using no adjustable parameters. Predictions are made for cesium on various crystal faces and on 21 transition metals. Comparison with available experimental data is good. A simplified appropriate treatment of adsorption theory is given. It is shown that a new dimensionless parameter characterizes, to a first approximation, electron emission S-curve performance for different adsorbates, substrates, and arrival dates. A recently initiated study of cesium adsorption on insulators was carried out both theoretically and experimentally. Among other things, it is discovered that the cesium is adsorbed on an insulator as a molecular ion with a binding energy of

1.65 ev. An analysis of the cesium vapor arc discharge is presented. Apparatus is described which permits continuous pumping of cesium vapor devices. Using this apparatus, the outgassing from an operating cesium diode was analyzed, and typical results are presented. Experimental data on the results of dosing an arc mode cesium diode with xenon and krypton are given, and a discussion of these results is included. Finally, a study is made which predicts the effect of nuclear reactor radiation on a cesium diode dosed with xenon gas. (auth)

14786 (NASA-TR-R-192) THERMAL AND THERMIONIC CHARACTERISTICS OF A LARGE-SCALE EXPERIMENTAL THERMIONIC CONVERTER. A. Vary (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Mar. 1964. 36p.

A thermionic energy converter based on a coaxial diode configuration was used to obtain information relative to problems associated with instrumenting and heating a large-scale converter and to determine certain thermal and thermionic characteristics. The cylindrical tungsten cathode, having an emitting area of 73.7 square centimeters, was operated at temperatures in the range 1200 to 2000°K. Diode thermal characteristics such as temperature gradients, temperature ratios, heat-flow distributions, and thermal emissivities were studied. Thermionic characteristics were determined in both a vacuum and a cesium vapor atmosphere. The investigation defined problems associated with thermal gradients on emitting areas, interelectrode resistive leakage caused by vapor deposition, determination of heat-transfer properties, and measurement of cathode emission properties. (auth)

14787 MAGNETOPLASMADYNAMIC ELECTRICAL POWER GENERATION WITH NONEQUILIBRIUM IONIZATION. Mostafa E. Talaat (Martin-Marietta Corp., Baltimore). Advan. Energy Conversion, 3: 595-611(Oct.-Dec. 1963).

The conditions necessary for magnetohydrodynamic electric power generation with nonequilibrium ionization are evaluated. Formulas are derived for the electron density, electrical conductivity, and the corresponding internal electric field as functions of electron temperature in a seeded, partially-ionized noble gas in the nonequilibrium state. Relations for the magnetic field necessary for magnetically-induced ionization are also obtained in forms suitable for both segmented electrode Faraday and Hall generators. Results obtained with the formulas are included. Electron densities are compared with those obtained from Saha's equation. (D.C.W.)

14788 RESEARCH ON OPTIMUM MACH NUMBER AT ENTRANCE TO MHD GENERATOR. A. Békiarian (Electricité de France, Paris). Rev. Inst. Franc. Petrole Ann. Combust. Liquides, 19: 129-43(Jan. 1964). (In French)

The search for greater efficiency in a M. H. D. (magnetohydrodynamic) project led to the consideration of an optimum income velocity (or Mach number) for the conducting fluid at the entrance to the generator. The means of determining this velocity is explained, and numerical results are given for different gases. A perfect gas and a combustion-dissociated gas were considered. The respective results were compared. These results showed that the use of a partially dissociated gas brings about an increase in the optimum Mach number. (auth)

14789 PROCEEDINGS, 16th ANNUAL POWER SOURCES CONFERENCE, 22-24 MAY 1962. Red Bank, N. J., PSC Publications Committee, 1962. 183p.

Separate abstracts were prepared for 5 of the 48 papers presented during sessions on fuel cell materials and mechanisms, fuel cell batteries and systems, thermal energy conversion, solar energy conversion, secondary batteries, primary batteries, and electrical-electrical energy conversion. (R.E.U.)

For abstracts of individual papers see: 14790, 14791, 14792, 14793, and 15575.

14790 RADIOACTIVE REGENERATIVE FUEL CELLS. J. F. Yeager, R. J. Bennett, and D. R. Allenson (Union Carbide Corp., New York). p.39-42 of "Proceedings, 16th Annual Power Sources Conference, 22-24 May 1962." Red Bank, N. J., PSC Publications Committee, 1962.

The electrochemical aspects of a nuclear radiation-energized electrical power source are discussed. Efficiency and engineering considerations are described. A gamma source is used to chemically regenerate acidified ferrous sulfate solutions, which are electrically decomposed, so that the net system reaction transforms radiation energy into electrical energy. (R.E.U.)

14791 DESIGN CONSIDERATION FOR GASOLINE-POWERED THERMIONIC GENERATORS. W. R. Martini (Atomics International, Canoga Park, Calif.). p.55-60 of "Proceedings, 16th Annual Power Sources Conference, 22-24 May 1962." Red Bank, N. J., PSC Publications Committee, 1962.

The requirements that a portable gasoline-powered thermionic power source must meet in, for example, an arctic environment are summarized, the engineering and design problems these requirements arise are discussed, and results of research on problem solutions are presented. (R.E.U.)

14792 PROGRESS IN THE CESIUM THERMIONIC CONVERTER. G. N. Hatsopoulos, S. Kitrilakis, and F. Lyczko (Thermo Electron Engineering Corp., Waltham, Mass.). p.60-4 of "Proceedings, 16th Annual Power Sources Conference, 22-24 May 1962." Red Bank, N. J., PSC Publications Committee, 1962.

Results are presented of experimental parametric studies of optimum operating conditions of Ta, Nb, Mo, Ir, W, and Re emitters over a wide range of emitter and collector temperatures, interelectrode spacings, and cesium pressures. A diode was used in the experiments. The design of a gasoline-fueled thermionic generator is discussed. (R.E.U.)

14793 RADIOISOTOPE POWER SOURCES. Wilfred L. Kershaw (Martin Marietta Corp., Orlando, Fla.). p.64-67 of "Proceedings, 16th Annual Power Sources Conference, 22-24 May 1962." Red Bank, N. J., PSC Publications Committee, 1962.

Recent developments in SNAP and Transit generators are discussed. Space and terrestrial uses are discussed. (R.E.U.)

14794 WATER-COOLED INSULATING WALLS FOR MHD GENERATORS. Martin E. Novack and Thomas R. Brogan (Avco Corp., Everett, Mass.). New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-348, 7p, $1.00. (CONF-102-36)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

A composite water-cooled wall for MHD generators was developed. This wall uses ordinary materials operating at their normal use temperature. The wall is capable of insulating against both induced and Hall electric fields. Heat-transfer rates as high as 1,700,000 Btu/hr sq ft and combustion-gas pressures up to 105 psia were attained.

The wall has withstood conditions that might be found in a typical central station plant, including ash and seed, for periods of over 100 hr, without deterioration. Although more endurance tests are required, it appears that the wall has promise for use in a central station MHD power plant. (auth)

14795 CURRENT STATUS AND FUTURE POTENTIAL OF THERMIONIC POWER GENERATION. Volney C. Wilson (General Electric Co., Schenectady, N. Y.). Paper No. CP 64-213, 22p. $1.00. (CONF-430-2)

From Institute of Electrical and Electronics Engineers Winter Power Meeting, New York, Feb. 1964.

A method is outlined for combining thermionic converters and steam turbines to obtain more electricity from nuclear station power plants. The various kinds of thermionic converters are described and a more detailed analysis is made of the high-cesium-pressure thermionic converter. It is shown that at this time converters are not sufficiently well developed to be useful for this application. A method is outlined for obtaining high generating capability and efficiency from thermionic converters. If dependable converters can be developed that produce 30 watts/cm^2 of converter emitter surface at 23% efficiency, then thermionic converter toppers for a 450 Mw(e), 32% efficient turbine system would increase the output of the station to 807 Mw(e) at 44% efficiency. A very preliminary estimate of the costs indicates that the capital investment would be about $203/kwe capacity and the total cost of generating electricity from this cascaded system would be about 4.6 mills/kw-hr. (auth)

Elementary Particles and Radiations

Refer also to abstracts 14773, 15126, 15308, and 15309.

14796 (AFCRL-63-166) RADIATION FROM A CHARGED PARTICLE PASSING THROUGH A CIRCULAR OPENING IN A PERFECTLY CONDUCTING SCREEN. Technical Note No. 3. I. Ronchi (Italy. Consiglio Nazionale delle Ricerche. Centro di Studio per la Fisica delle Microonde, Florence). Mar. 1963. 24p. (AD-413342)

The radiation arising in the passage of a charged particle in uniform straight motion through a circular opening in an ideally conducting plane screen, normal to the particle path, is investigated. The exact solution is obtained in the form of a series of spherical functions. Numerical evaluation is also considered. (auth)

14797 (AFOSR-4737) HIGH ENERGY PHYSICS PROPERTIES OF ANTIPROTONS, K MESONS, HYPERONS, AND PIONS. A. G. Ekspong (Stockholm. Univ.). Oct. 31, 1962. 24p. (AD-407166)

In an investigation of 537 interaction stars in nuclear emulsion exposed to a beam of 2000 Mev/c antiprotons, mixed with some pions and muons, about 215 stars were attributed to antiprotons, the rest to pions. The antiproton mean free path at this momentum was found to be 26 ± 5 cm. The average number of charged pions outside the capturing nucleus is 2.64 for antiproton stars; the average pion energy is 430 ± 50 Mev, including the rest mass of 140 Mev. The average pion multiplicity in the annihilation process is found to be about 5.0. Detailed calculations of pion interactions inside the nucleus were performed. No hyperon (Σ) was found. In another investigation of 2000 Mev/c pions, 281 interactions with emulsion nuclei were studied. The mean number of emitted charged pions is 1.21 ± 0.03/star; the fraction of stars with charged secondary pions is 75 ± 3%. The results agree well with the predictions of the cascade calculations of Metropolis, but are in disagreement with the experimental results by Crew. A line was discovered in the momentum spectrum of the $\Sigma^-\pi$ system emitted from nuclei when mesons (K^-) are absorbed at rest. The line was unexpectedly narrow, contained in a band of width ±10 Mev/c. Its position was determined to be 171 ± 2 Mev/c. By a careful study of the short recoil tracks from the residual nucleus and also by other means it was concluded that the line should be interpreted as being caused by a reaction in which a new particle, Y**, is emitted. The reaction that fits the observations is $K^- + C^{12} \rightarrow Y^{**} + B^{11}$. It is concluded that the mass of Y** is 1404.7 ± 0.4 Mev. This is close to the value for Y_0^{*} (about 1405 Mev). The mass width of the Y** is unexpectedly small, <1.4 Mev, whereas for Y_0^{*} a width of 50 Mev is reported. The investigation of the pion-electron scattering cross section with 16 Bev/c pions incident on a hydrogen bubble chamber was concluded. In a fiducial volume of chamber about 1000 scattering events were analyzed in the electron energy region from 30 Mev up to the maximum possible (7300 Mev). The differential and integrated cross sections agree well with those predicted by the Bhabha formula for a point charge pion over most of the energy region investigated. A tendency to lower values of the cross sections in the region of high momentum transfers may be due to an extended structure of the pion. However, the statistical errors are such as not to rule out a zero radius of the pion. (auth)

14798 (CEA-2306) CONTRIBUTIONS A L'ÉTUDE DES RÉACTIONS $\pi^+ + p \rightarrow \pi^+ + p + \pi^0$ ENTRE 0.5 ET 1.5 GeV/c. (Contribution to the Study of the Reaction $\pi^+ + p \rightarrow \pi^+ + p + \pi^0$ Between 0.5 and 1.5 Gev/c). Bernard Thevenet (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1963. 79p.

Thesis submitted to Universite, Paris.

The total production cross section of γ accompanied by charged secondaries in $\pi^+ p$ interactions between 0.5 and 1.5 Bev/c was measured. The cross section of the reaction $\pi^+ p \rightarrow \pi^+ \pi^0 p$ was obtained. Only the cross section of $\pi^- p \rightarrow \pi^0 +$ (charged particles) could be determined because the lack of information on multiple production. The experimental results were compared with the predictions of simple production models. A method for calculation of high energy γ-ray efficiency of detectors with lead converters is given. (auth)

14799 (CERN-61-1(p.1-5)) THE INTERACTIONS OF FREE HYPERONS. F. R. Stannard (London. Univ. University Coll.).

Some experiments and experimental data on hyperon(Σ) and hyperon(Λ) interactions are discussed, together with theoretical predictions for the interactions. (D.C.W.)

14800 (CERN-64-1(p.191-9)) MESON THEORY OF HYPERON-NUCLEON FORCES. J. J. de Swart (European Organization for Nuclear Research, Geneva).

The constants and form of a potential for describing hyperon-nucleon interactions, particularly Λ-N scattering, are determined. Only pion contributions to the hyperon-nucleon forces are considered. The coupling constant $f_{\Lambda\Sigma}$ is determined to be of the same order as f_{NN}, but $f_{\Sigma\Sigma}$ is much smaller. (D.C.W.)

14801 (CONF-22-32) PION-NUCLEON SCATTERING IN THE BOUNDARY CONDITION MODEL. II. THE SECOND RESONANCE. H. Goldberg and E. L. Lomon (Mas-

sachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Oct. 1963. Contract AT(30-1)-2098. 56p.

From American Physical Society, 1963 Annual Meeting, New York, Jan. 1963.

It is shown that consideration of an explicit coupling to the ρ-N channel produces good agreement with experimental information on the second π-N resonance. The dynamics are represented by the boundary condition model, satisfying analytic and unitary requirements. The main effect is due to the coupling to virtual mesons (ρ). All the isotopic splitting of the $T = 3/2$ D states can be explained by the coupling to the ρ-N channel. By altering the coupling in accordance with the one-pion-exchange diagram, the $T = 3/2$, 850-Mev "shoulder" is obtained. The boundary condition radius agrees with the relevant Feynman diagrams of the strip approximation. (auth)

14802 (IFA-HE/50) ON THE NEUTRAL PION MULTIPLICITY IN REACTION $\pi^- + p \rightarrow \pi^- + p + n\,\pi^0$ AT (7-8) Gev. H. Hulubei, C. Besliu, et al. (Bucharest. Universitatea "C. I. Parhon"); A. Mihul, et al. (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). Nov. 1, 1963. 7p.

From an analysis of bubble chamber events at 7.3 Bev/c, the average number of mesons(π^0) produced in the interaction $\pi^- - p \rightarrow \pi^- - p - n - \pi^0$ was estimated to be 2.5×0.2, in agreement with the prediction of the parallel-momentum conservation law (2.7 ± 0.4). (D.C.W.)

14803 (ISU-10) A PRELIMINARY INTERPRETATION OF MASS. E. W. Bastin and C. W. Kilmister (Cambridge Language Research Unit, Cambridge, England). Feb. 1963. Contract AF61(052)-331. 32p. (AFOSR-5049; AD-413869)

An algebraic hierarchy was formulated previously without any physical interpretation. It is assumed that a particular hierarchy of this general type corresponds to a proton or an electron in certain circumstances — the whole hierarchy being necessary to represent the whole complex of observations of it. Based on this assumption constraints are applied to the process of hierarchy construction in such a way that one can decompose hierarchy into 2 independent parts for the purpose of representing unstable particles that disintegrate into at least 2 decay products. (auth)

14804 (ITP-98) CONSERVATION OF WEAK INTERACTION CURRENTS BY PROJECTION. Frank Chilton (Stanford Univ., Calif. Inst. of Theoretical Physics). Sept. 1963. 8p.

It is shown that the form of the weak interaction permits the concept of a conserved current to be extended to a much wider class of weak interactions. (auth)

14805 (JINR-E-1436) THEORETICAL ASPECTS OF HIGH-ENERGY PHYSICS. D. I. Blokhintsev, N. N. Bogolyubov, M. A. Markov, and I. Ya. Pomeranchuk (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1963. 20p. (CONF-114-25)

From the International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

The principles and validity of the present theory of high-energy physics are indicated, and experimental areas of prime importance to the development and verification of the theory are discussed. (D.C.W.)

14806 (JINR-E-1496) ON THE PROBLEM OF BOUND STATES IN PION-PION INTERACTIONS. G. Domokos and P. Suranyi (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 8p.

The problem of bound state poles in π-π interactions was investigated in the framework of the Bethe-Salpeter theory. For vanishing energy and small coupling constant, there are no poles on the physical sheet of the four-dimensional angular momentum plane, while there is a pair of poles on the first unphysical sheet. (auth)

14807 (JINR-E-1503) INVARIANT EXPANSIONS OF RELATIVISTIC AMPLITUDES. N. Ya. Vilenkin and Ya. A. Smorodinsky (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 22p.

The integral transforms of functions in terms of orthogonal systems of the Laplacian eigenfunctions on the hyperboloid are considered. Formulas are given for direct and inverse expansions in four orthogonal coordinate systems of the Lobachevsky's space. All the transformations are connected with expansions on a cone. The expansions are not unitary in general, but become unitary for certain values of the quantum numbers. (auth)

14808 (JINR-E-1520) ASYMPTOTIC RELATIONS BETWEEN SCATTERING AMPLITUDES IN LOCAL FIELD THEORY. A. A. Logunov, Nguyen Van-Hieu, and I. T. Todorov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 38p.

A number of asymptotic relations among the amplitudes, cross sections, and polarizations of different scattering processes at high energies was obtained on the basis of the general postulates of the local relativistic quantum field theory. The Phragmen-Lindelof theorem in the theory of analytical functions was used, and the amplitudes were assumed to be nonoscillatory at high energies. (auth)

14809 (JINR-P-1494) PIONNYE REZONANSY. (Pion Resonances). S. A. Bunyatov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 39p.

The experimental data on pion resonances are discussed, and the main properties of these resonances are tabulated. 132 references. (auth)

14810 (JINR-P-1506) π-MEZONNYE REZONANSY ROZHDENNYE SO STRANNYMI CHASTITSAMI V π^--p VZAIMODEISTVIYAKH PRI 7.5 Gev/c. (Pion Resonances Produced Together With Strange Particles in π^--p Interactions at 7 Gev/c). V. A. Belyakov, V. I. Veksler, N. M. Viryasov, E. N. Kladnitskaya, G. I. Kopylov, A. Mikhul, V. N. Penev, E. S. Sokolova, and M. I. Solovev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1964. 20p.

The pion resonances produced together with strange particles were investigated. It was found that the meson (ρ) is produced together with Λ-K pairs in events with a charged particle multiplicity of 4. The cross section for such production is 20 ± 8 μb. Estimates of (ω) and (η) resonance production are given. The peak in the distribution of the effective mass of four mesons(π) near 1340 Mev is discussed. (auth)

14811 (JINR-P-1508) REZONANSIYE VZAIMODEISTVIYA VYSTRYKH CHASTITS S YADRAMI. (Resonance Interactions of Fast Particles With Nuclei). V. G. Grishin and M. I. Podgoretskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1964. 10p.

Some characteristic features of the resonance interaction of fast mesons with nuclei in the energy region, in which the N^* and Y^* isobar production is possible, are considered. It is shown that the so-called nuclear isobar is also likely to be produced. In the case of elastic scattering the width and the mass of the nuclear isobar are determined only by the width of the corresponding resonance and by the interaction of the isobar with the nucleons of the nucleus. There is no increase in the width of the isobar

state of nuclei due to the nucleon motion in the nucleus. A similar conclusion holds also for inelastic two-particle reactions. The study of the position and the width of the maximum in the cross section for meson interaction with nuclei allows to obtain some information about the character of Y*N and NN* interactions. From this point of view it is especially interesting to investigate reactions of the type $K^-d \rightarrow \Lambda n$, $K^- He^4 \rightarrow \Lambda H^3$, and the like. (auth)

14812 (JINR-P-1511) N-N VZAIMODEISTVIYA V POLYUSNOM PRIBLIZHENII. (N-N Interactions in Pole Approximation). P. Smrz and Tsu-chan Huang (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 7p.

The momentum spectra of the recoil protons in N-N interactions were calculated in the pole approximation for primary nucleon energies from 2.8 to 9 Bev. Comparison with the available experimental data shows no noticeable deviations. The characteristic shape of the curves is weakly energy dependent, but the shapes of the spectra for p-p and p-n collisions are considerably different. This is due to the difference in the isospin coefficients and is a characteristic feature of the exchange of one meson. (auth)

14813 (KR-65) AN INTRODUCTION TO SPIN DENSITY MATRIX FORMALISM AND ITS APPLICATIONS IN THE MATHEMATICAL TREATMENT OF POLARIZED THERMAL NEUTRON SCATTERING. O. Steinsvoll (Norway. Institutt for Atomenergi, Kjeller). Aug. 1963. 46p.

The concept of the spin density matrix is developed and used in the description of polarized thermal neutron beams. The polarization effects involved in the elastic and inelastic scattering of polarized neutrons (spin wave scattering and magneto-vibrational scattering) are calculated. The performance of depolarizing devices (shims) and spin flipping devices are also described. (auth)

14814 (NIRL/R/57) PROTON-PROTON SCATTERING FROM 20 TO 50 Mev. C. J. Batty and R. S. Gilmore (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England). Nov. 1963. 42p.

The present state of the experimental investigation and theoretical analysis of proton-proton scattering in the energy region from 20 to 50 Mev is surveyed. The results of new phase-shift analyses of data at 25.65 and 51.65 Mev and the choice of further experiments required to improve the analyses are also discussed. (auth)

14815 (NP-13616) TABLES OF $F_{mn}(y) = \int_0^y E_m(x)E_n \times (y-x)dx$ AND $G_{mn}(y) = \int_0^y E_m(x)E_n(x)dx$. Research Bulletin No. 3. Robert R. Ligouri and Raymond L. Murray (North Carolina State Coll., Raleigh. School of Physical Sciences and Applied Mathematics). Aug. 1962. 87p.

Integrals of products of the Placzek functions $E_m(x)$ with $E_n(y-x)$ and with $E_n(x)$, are tabulated for y values from 0 to 10 and for integers m and n from 1 to 10. The integrals, which arise in the plane scattering of particles or radiation, may be used to calculate neutron distributions in nuclear reactors and the transmission of radiation in shields. (auth)

14816 (NP-13618) ASIMPTOTIKA AMPLITUD OBRAZOVANIYA CHASTITS PRI "POCHTI-UPRUGIKH" LIVNEVYKH PROTSESSAKH. (The Asymptotics of Amplitudes in the Formation of Particles in Quasi-elastic Collision Processes). A. M. Popova and V. A. Ter-Martirosyan (Akademiya Nauk S.S.S.R. Institut Teoreticheskoi i Eksperimental'noĭ Fiziki, Moscow and U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoĭ Energii). 1963. 37p.

The asymptotics of inelastic processes, particularly of reactions of the type $a + b \rightarrow c + d + e$, are obtained using the method of complex angular momenta. Quasielastic collisions in which two of three particles are produced with small energy in their center-of-mass system are considered. The expansion in terms of the partial amplitudes with definite helicity corresponding to definite values of the total momentum j of the whole system and orbital momentum l' of some pair of particles produced is used. The analytical continuations (with two types of signature) into a plane of complex values of the total angular momenta j are obtained, and their analytical properties in this plane are investigated. It is shown that partial amplitudes vanish at all nonphysical values of right signature at even j for the amplitude with positive signature and odd j for negative ones less than the value λ' of the momentum projection. The kinematics of quasielastic and essentially inelastic collisions of the type $a + b \rightarrow c + d + e$ are briefly considered. The asymptotics of the quasielastic collisions are obtained in a form convenient for consideration of the limiting case of essentially inelastic collisions. (auth)

14817 (NP-13644) RELATIVISTIC PARTICLE DYNAMICS AND THE S-MATRIX. Technical Report No. 319. R. Fong and J. Sucher (Maryland. Univ., College Park). July 1963. 153p.

Direct interaction theories are examined from the viewpoint of relativistic scattering theory and the associated concept of asymptotic covariance. It is pointed out that with any two-particle hamiltonian which has no bound states there can be associated a variety of representations of the Lie algebra of the inhomogeneous Lorentz group (IHLG). It is shown that the requirement of asymptotic covariance ensures both the covariance of the S-matrix and the existence of a unique representation of the IHLG to be associated with the relativistic two-particle system. The connection between the Lie algebra, the covariant form of the S-matrix, and the uniqueness of $\underset{\sim}{K}$, the generator of pure Lorentz transformations, is thereby clarified. These considerations are extended to include bound states. The form of the hamiltonian given by Bakamjian is shown to satisfy asymptotic covariance and, moreover, to be the most general form of interest from the viewpoint of relativistic scattering theory, thereby including as a special case a form of the hamiltonian suggested by Sudarshan. It is also proved that relativistic hamiltonians of this type do not admit the usual notion of a coupling constant. (auth)

14818 (NP-13677) OTSUTSTVIE RASPADOV $\eta \rightarrow 2\pi$ I SOKHRANENIE PRO STRANSTVENNOI I KOMBINIROVANNOI CHETNOSTI. (Absence of $\eta \rightarrow 2\pi$ Decay and Retention of Spacial and Combined Parity). I. Yu. Kobzarev and L. B. Okun' (Akademiya Nauk S.S.S.R. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1963. 5p.

It is shown that the absence of $\eta \rightarrow 2\pi$ decays makes it possible to restrict the possible violations of parity and charge parity invariance in strong interactions. (auth)

14819 (NP-13680) RECHERCHES SUR L'APPLICATION DE LA METHODE DE MONTE-CARLO DANS LES PROCESSUS DE PHYSIQUE NUCLEAIRE A HAUTE ENERGIE: INTERACTION DES PIONS NEGATIFS DE 4.5 Gev (THESE). (Investigations on the Application of the Monte Carlo Method in High-Energy Nuclear Physics Processes: Interaction of 4.5-Gev Negative Pions (thesis)). Jean Grea (Lyon. Universite). 1961. 63p.

The applicability of the Monte Carlo method to the study of the interaction of negative pions at 4.5 Bev is investigated. The hypotheses at the basis of calculations on intra-

nuclear cascades are reviewed. The principles of the Monte Carlo method and its adaptation to cascades of π-nucleon collisions are described. Elastic and inelastic processes are then studied. The results show that the Monte Carlo method is applicable without difficulty to collisions of the elastic type and to a cascade of such collisions. Thus, the results relative to the coefficient of forbiddenness calculated for pions at 4.5 Bev are in excellent agreement with those obtained by a different method. The occurrence of inelastic collisions present some difficulties. It is necessary to use a treatment respecting both the spirit of the simulation method and the conditions of compatibility between conditions imposed by the dynamics. It was shown that a previous attempt has serious objections and an alternate approach was proposed. Curves and charts that can be used in the case of collisions of 4.5-Bev pions are presented. Their generalization to other particles and energies presents no difficulty. (J.S.R.)

14820 (UCRL-11163) NUCLEAR DEMOCRACY AND BOOTSTRAP DYNAMICS. Geoffrey F. Chew (California. Univ., Berkeley. Lawrence Radiation Lab.). Dec. 9, 1963. Contract W-7405-eng-48. 14p. (CONF-417-1)

From American Physical Society Meeting, Pasadena, Calif., Dec. 1963.

The assumption of the dynamical equivalence of all nuclear particles is discussed and contrasted with conventional electrodynamics and weak interaction theory. The relation with the idea that all strong forces are Yukawa forces is brought out, and an attempt is made to explain the difference in properties between baryons and mesons on one hand and ordinary nuclei on the other. The bootstrap mechanism is explained, with emphasis on the crucial role of crossing matrices and the Froissart limit. It is shown that the combined requirements of unitarity and analyticity of the s-matrix can place both lower and upper limits on the particle population in a democracy. (auth)

14821 (UR-875-20) LOWER BOUNDS ON THE LEHMANN WEIGHTS IN SPIN ZERO MESON THEORY. C. R. Hagen (Rochester, N. Y. Univ.). Jan. 15, 1964. Contract AT(30-1)-875. 11p.

It is shown within the framework of conventional spin-zero meson theory that if all renormalizations are assumed finite, the Lehmann weights of the fermion and meson Green's functions cannot decrease arbitrarily rapidly as a function of energy. (auth)

14822 CONSEQUENCES OF NEUTRON-PROTON MASS DIFFERENCE IN THE KINEMATICS OF NEUTRON-PROTON SCATTERING. Ajoy K. Ghatak (Cornell Univ., Ithaca, N. Y.). Am. J. Phys., 32: 163-6(Feb. 1964).

A detailed study of the kinematics of neutron-proton, proton-neutron and neutron-neutron scattering (n-p, p-n and n-n scattering, respectively) reveals a significant difference in the elastic differential cross section in laboratory directions corresponding to the near backward direction in the center of mass system. Based on the finite n-p mass difference, the n-p scattering cross section goes to ∞ at 86°59.5′, the p-n scattering shows a slight amount of backward scattering and the n-n scattering cross section equals zero for all laboratory angles greater than 90°. Most treatments of n-p scattering limit the discussion of the kinematics of the scattering process to a neutron-proton mass ratio to unity. It is of interest to consider the extent to which the actual difference in mass influences the angular distribution of the scattered particle. The consequences of the small, but nonnegligible, n-p mass difference in the kinematics of scattering are discussed. Although it is not possible to obtain free neutrons at rest and hence p-n scattering cannot be observed in the laboratory, it, with n-n scattering is discussed here to get an idea as to what the kinematics of n-p scattering would be if neutrons were lighter than protons and if the neutron mass were exactly equal to the proton mass. (auth)

14823 ABOUT THE ENERGY PARAMETERS OF THE TWO-BODY INTERACTIONS IN THE $(p_{1/2})^2$, $(p_{1/2}\ 2s_{1/2})$ AND $(p_{1/2}\ d_{3/2})$ CONFIGURATIONS. Mario Alves Guimarães (Instituto Tecnológico de Aeronautica, São Jose dos Campos, Brazil). Anais Acad. Brasil. Cien., 35: 309-16(Sept. 30, 1963).

The energy parameters of the two-body interactions in the $(p_{1/2})^2$, $(p_{1/2}\ 2s_{1/2})$, and $(p_{1/2}\ d_{3/2})$ configurations were obtained with the help of data from N^{14}, N^{13}, and C^{13}. To show that the values obtained with the method used in this work have actual physical significance, they were applied to the calculation of binding energies of some nuclei in the region A = 14 to 16. The numerical values of the binding energies and a discussion of the method used for computation of the interactions of the nucleons in the $(p_{1/2})^3$, $(p_{1/2})^2\ 2s_{1/2}$ and $(p_{1/2})^4$ configurations as functions of the parameters of the $(p_{1/2})^2$ configuration are presented. The parameters obtained in the N^{14} nucleus were compared with similar ones in C^{14} showing new evidences for the equality of the T = 1 neutron-neutron and proton-neutron interactions. The numerical values obtained for the parameters of the $(p_{1/2}\ 2s_{1/2})$ and $(p_{1/2}\ d_{3/2})$ configurations were compared with similar ones obtained by Talmi and Una. (auth)

14824 SELF-CONSISTENCY IN HYPERON DYNAMICS. Pekka Tarjanne (Inst. of Technical Physics and Tech., Otaniemi, Finland). Ann. Acad. Sci. Fennicae, Ser. A VI, No. 139, 12p. (1963).

The structure of the hyperons and their resonances is investigated by studying some of the most important Born terms. SU_3 symmetry is used to get relations between pling constants. The signs and strengths of the forces in different spin states and isospin channels are found to be such that a self-consistent picture can be found that includes the $\Lambda\pi$, $\Sigma\pi$ and $N\overline{K}$ systems in the Y = 0 channel and $\Xi\pi, \Lambda\overline{K}$ and $\Sigma\overline{K}$ in the case Y = −1. Also off-diagnonal (transition) scattering amplitudes must be treated and the vector meson exchange processes are shown to give important contributions. The results encourage the use of bootstrap ideas in further baryon calculations. (auth)

14825 CROSSING RELATIONS FOR HELICITY AMPLITUDES. T. L. Trueman and G. C. Wick (Brookhaven National Lab., Upton, N. Y.). Ann. Phys. (N. Y.), 26: 322-35(Feb. 20, 1964). (BNL-7301)

Crossing relations for helicity amplitudes for particles of arbitrary spin are formulated without recourse to the introduction of scalar amplitudes. The basic assumption is that the amplitudes are simply related by analytic continuation; the path of continuation is carefully specified. The relations are given a simple geometrical interpretation. The relation between $\pi N \to \pi N$ and $\pi\pi \to N\overline{N}$ obtained in this way agrees with that obtained by direct elimination of scalar amplitudes. (auth)

14826 SYMMETRY PROPERTIES OF n-PION WAVE FUNCTIONS. M. Grynberg and Z. Koba (Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw). Ann. Phys. (N. Y.), 26: 418-41(Feb. 20, 1964).

Symmetry properties of the configurational wave functions of an arbitrary number of pions are examined in the nonrelativistic approximation. General behavior of solutions of the n-pion Schrödinger equation is described in the case where the interaction hamiltonian depends only on the

over-all relative distance R, and a scheme of generalized partial wave classification is introduced by means of the grand angular momentum Λ and the total angular momentum J. Each of these subsets of the configurational wave functions forms an invariant subspace of the symmetry group S_n. A systematic method of working out how many times and what kinds of irreducible representations of S_n are included in the representation acting on this space of wave functions specified by Λ and J is presented. The results thus obtained for $\Lambda \leq 4$ are tabulated. (auth)

14827 THE COHERENCE OF INDUCED RADIATION. Harry Paul (Inst. for Special Problems in Theoretical Physics, German Academy of Sciences, Berlin). Ann. Physik (7), 12: 290-301(1963). (In German)

Since the energy, U, and the electric field strength, F, of a quantized electromagnetic field cannot be sharp at the same time, for a coherent state of the field it is obvious that the U and F should be controlled as little as possible. Under the assumption that only a characteristic vibration of the field is excited, the indefinite ΔU and $\sigma = \sqrt{\langle F^2\rangle_t - \langle F\rangle_t^2}$ were calculated before and after the induced emission of a photon and also for the case of a coherent and a (completely) incoherent induced field. In both cases the induced emission σ increased by the amount $\delta\sigma = \sigma/2N$ (N is average number of present photons). The value for δσ was much smaller for a coherent than an incoherent field, since the same is true for σ. In this sense induced radiation can be designated as coherent radiation. (tr-auth)

14828 IRREDUCIBLE REPRESENTATIONS OF THE SU_3 GROUP. J. P. Antoine (Université, Louvain, Belg.). 150-62(Dec. 20, 1963). (In French)

In the connection with the present use of the SU_3 group for high symmetry schemes of strong interactions, the irreducible representations of the group are reviewed. The geometrical method of carton, which characterizes every irreducible representation by its weight diagram, is used. A simple formula is derived for the weight diagrams, permitting them to be drawn without any calculations. (auth)

14829 FIVE PION ISOSPIN WAVE FUNCTIONS. M. Grynberg and Z. Koba (Univ. of Warsaw and Universitet, Copenhagen). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 11: 701-6(1963).

A complete orthonormal set of isospin wave functions is presented for five π mesons, which possess definite values of total isospin, a third component T_3, and definite symmetry that allows the wave functions to transform under any permutation according to a certain irreducible representation of the symmetry group S_5. (R.E.U.)

14830 THE SELF-CONSISTENT MATHIEU PROBLEM. J. Vail (Univ. of Manitoba, Winnipeg, Can.). Can. J. Phys., 42: 329-48(Feb. 1964).

The one-dimensional many-fermion system with weak attractive interaction, which is known to have self-consistent Hartree solutions corresponding to either uniform or spatially periodic mass density, is discussed as a physical model and as a mathematical problem. The Hartree problem for sinusoidal mass density leads to the self-consistent Mathieu problem, which is analyzed for the case where the first Brillouin zone boundary does not necessarily coincide with the Fermi surface (no energy gap between ground and single-particle excited states). The Mathieu equation is solved in the weak-binding approximation in the vicinity of the two lowest band gaps, the self-consistency condition is analyzed in detail, and the N-particle energy is calculated for various cases. The results suggest that the periodic state will not have lower energy than the uniform state unless the first gap in the one-particle spectrum lies near the Fermi surface. The fact that self-consistency can be obtained for a considerable range of periodicities suggests that the periodic solutions may be of importance in some many-fermion systems. (auth)

14831 THE POSITION OPERATORS OF CHARGED PARTICLES OF SPIN 0 OR h 2 IN A CONSTANT MAGNETIC FIELD. M. Baktavatsalou (Institut Henri-Poincare, Paris). Compt. Rend., 258: 474-6(Jan. 13, 1964). (In French)

The position operators corresponding to the nonrelativistic and extremely relativistic cases are calculated for particles of spin ħ/2. The position operator for spin-zero particles is also obtained for the nonrelativistic case. (D.C.W.)

14832 PRODUCTION OF VERY HIGH-ENERGY MUON BEAMS BY ELECTRON INTERACTIONS. Gérard Clément (Collegè de France, Paris). Compt. Rend., 258: 477-9 (Jan. 13, 1964). (In French)

The spectrum of muons produced in a thick lead target by bremsstrahlung from a high-energy electron was calculated for conditions appropriate to beam production. (tr-auth)

14833 ON APPLICATION OF THE REGGE POLE HYPOTHESIS TO HIGHLY INELASTIC PROCESSES. Ziro Koba (Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw). Fortschr. Physik, 11: 583-5(1963).

The validity of the Regge pole theory for highly inelastic processes is discussed. It is indicated that a possible way out of the difficulty may be found by taking into account the threshold behavior in the crossed channel. (M.C.G.)

14834 RESONANT STATES OF NUCLEON AND BILOCAL FIELD THEORY. Jerzy Rayski (Universität, Bern). Helv. Phys. Acta, 36: 1081-94(1963).

A bilocal scalar field was investigated as a model of "nucleon" (and its resonant states) in interaction with a local scalar field as a model of "pion." Precisation of the concept of reciprocity, a bilocal free field, the problem of interaction, equivalence with a form-factor theory, an alternative formulation, correspondence and macrocausality, and quantization of the bilocal field are discussed. (M.C.G.)

14835 ON THE STRUCTURE OF THE THREE-PARTICLE SCATTERING OPERATOR IN GENERALIZED BOLTZMANN EQUATION FOR HOMOGENEOUS GASES. J. Stecki (Univ. of California, Los Angeles). J. Chem. Phys., 40: 1197-1200(Mar. 1, 1964).

It is shown that the weak-coupling version of Bogolyoubov theory in a form recently derived leads to a three-particle term in the equation of evolution of the velocity distribution function, in which the finite duration of collisions is taken into account in a way strictly equivalent to the Prigogine theory in the Markovian approximation. (auth)

14836 INELASTIC SCATTERING OF 390-V ELECTRONS BY HELIUM, HYDROGEN, METHANE, CYCLOHEXANE, ETHYLENE, AND WATER. Edwin N. Lassettre and Stanley A. Francis (Ohio State Univ., Columbus). J. Chem. Phys., 40: 1208-17(Mar. 1, 1964).

Electron impact spectra obtained by the inelastic scattering of 390-v electrons from helium, hydrogen, methane, ethane, cyclohexane, ethylene, and water are given. It is shown experimentally that, at small scattering angles and a fixed velocity-analyzer setting, the scattered current as a function of pressure contains a maximum. The theory of this effect is discussed. (auth)

14837 THEORETICAL CALCULATION OF ELECTRON COLLISION CROSS SECTIONS FOR THE $1^1S \rightarrow 2^1P$ TRANSITION IN HELIUM. Edwin N. Lassettre and Ernest A. Jones (Ohio State Univ., Columbus). J. Chem. Phys., 40: 1218-21(Mar. 1, 1964).

Using the Born approximation, collision cross sections for the $1^1S \rightarrow 2^1P$ transition in helium were calculated. (P.C.H.)

14838 DETERMINATION OF GENERALIZED OSCILLATOR STRENGTHS FOR MOLECULAR HYDROGEN BY ELECTRON IMPACT. Edwin N. Lassettre and Ernest A. Jones (Ohio State Univ., Columbia). J. Chem. Phys., 40: 1222-31(Mar. 1, 1964).

Inelastic electron collision cross sections at small scattering angles were determined for molecular hydrogen using electrons whose initial kinetic energies range from 324 to 461 v. Oscillator strengths were calculated from the data and compared with values determined from ultraviolet absorption data by others. The oscillator sum was calculated and compared with theory and calculated refractive indices compared with experiment. Agreement is good. (auth)

14839 ELECTRON SPECTROMETER FOR THE STUDY OF INELASTIC ELECTRONIC COLLISION CROSS SECTIONS. E. N. Lassettre, A. S. Berman, S. M. Silverman, and M. E. Krasnow (Ohio State Univ., Columbus). J. Chem. Phys., 40: 1232-42(Mar. 1, 1964).

An apparatus for the study of inelastic electronic collision cross sections of molecules as a function of scattering angle is described. The accuracy of excitation potential and collision cross section measurements is illustrated by means of examples involving helium, carbon monoxide, and oxygen. (auth)

14840 INELASTIC SCATTERING OF ELECTRONS BY HELIUM. E. N. Lassettre, M. E. Krasnow, and S. Silverman (Ohio State Univ., Columbus). J. Chem. Phys., 40: 1242-8(Mar. 1, 1964).

Electron collision cross sections as a function of scattering angle are reported for four transitions in helium including one at the ionization limit. Incident electrons of kinetic energy 511 v are employed. (auth)

14841 COLLISION CROSS-SECTION STUDY OF TWO TRANSITIONS IN NITROGEN. Edwin N. Lassettre and Marvin E. Krasnow (Ohio State Univ., Columbus). J. Chem. Phys., 40: 1248-55(Mar. 1, 1964).

Electron collision cross sections at three voltages were determined for two transitions in nitrogen. One of these corresponds to the Lyman–Birge–Hopfield bands, a forbidden system, and it is shown that the collision cross sections are compatible with the term symbol assignment for the excited state. (auth)

14842 INELASTIC COLLISION CROSS SECTIONS OF CARBON MONOXIDE. E. N. Lassettre and S. M. Silverman (Ohio State Univ., Columbus). J. Chem. Phys., 40: 1256-61(Mar. 1, 1964).

Electron collision cross sections for three transitions in carbon monoxide were determined as a function of angle. The results are in good accord with the general predictions of the Born approximation. (auth)

14843 ELECTRONIC COLLISION CROSS SECTIONS AND OSCILLATOR STRENGTHS FOR OXYGEN IN THE SCHUMANN–RUNGE REGION. Edwin N. Lassettre, S. M. Silverman, and Marvin E. Krasnow (Ohio State Univ., Columbus). J. Chem. Phys., 40: 1261-5(Mar. 1, 1964).

Electron collision cross sections were determined for the transition in oxygen corresponding to the dissociation continuum of the Schumann–Runge bands. Generalized oscillator strengths were calculated from the data and extrapolated to zero momentum change for the colliding electron. The extrapolated value obtained, when integrated over the transition, is 0.230. This value was compared with oscillator strengths obtained from ultraviolet absorption spectra by others. (auth)

14844 ADDITIONAL COLLISION CROSS SECTIONS FOR HELIUM ESPECIALLY IN THE IONIZED CONTINUUM. S. M. Silverman and Edwin N. Lassettre (Ohio State Univ., Columbus). J. Chem. Phys., 40: 1265-71 (Mar. 1, 1964).

Additional data on the cross sections for the $1^1S \rightarrow 2^1P$ transition are reported and compared with extended theoretical calculations. Some additional results on the $1^1S \rightarrow 2^1S$ transition are also reported. Collision cross sections and oscillator strengths were determined for several excitations in the ionized continuum. Oscillator strengths agree well with theory except in the vicinity of the double electron excitations. Two peaks that involve simultaneous excitation of two electrons were observed. A discontinuity in the ionized continuum on passing through a peak corresponding to a double excitation was observed. (auth)

14845 HIGHER-RESOLUTION STUDY OF THE ELECTRON-IMPACT SPECTRUM OF HELIUM. Ausma M. Skerbele and Edwin N. Lassettre (Ohio State Univ., Columbus). J. Chem. Phys., 40: 1271-5 (Mar. 1, 1964).

An electron source is described that provides, by means of an electrostatic velocity analyzer, for velocity selection on an electron beam before scattering. The energy width of the electron beam is sufficiently reduced to resolve the transitions to the 5^1P and 6^1P states in helium. These states are separated by 0.17 v. Relative oscillator strengths for two additional members of the Rydberg series $1^1S \rightarrow m^1P$ were determined by study of the zero angle electron scattering. (auth)

14846 CALCULATION OF ELECTRON SCATTERING FACTORS. I. NONRELATIVISTIC THEORY. J. Karle (Naval Research Lab., Washington, D. C.). and R. A. Bonham. J. Chem. Phys., 40: 1396-1401 (Mar. 1, 1964). (TID-19568)

Scattering factors for the elastic scattering from uranium and argon of 40-kv electrons were obtained by partial wave analysis. In the case of argon both Thomas–Fermi–Dirac and Hartree–Fock fields were used in the calculation. For uranium, only the Thomas–Fermi–Dirac field was utilized. Various approximate techniques for obtaining the partial waves as well as direct numerical integration of the Schrödinger equation were employed. For the first time accurate numerical solutions of the electron scattering problem in the kilovolt energy range, within the framework of the usual nonrelativistic scattering theory, were obtained. Uncertainties in the scattering factors and in the use of the various approximate techniques for obtaining partial waves are discussed. (auth)

14847 INTERACTION AND THERMALIZATION OF IONS IN A HOT PLASMA. G. Rakavy and D. Shalitin (Hebrew Univ., Jerusalem). J. Nucl. Energy, Pt. C, 6: 15-28 (Jan.-Feb. 1964).

The moderation and thermalization of ions by a hot plasma is treated by a method that is a generalization of

the age theory of continuous slowing down. Formulas are given for the slowing down coefficients of an ion in a hot plasma. The method is illustrated by calculating the thermalization of a monoenergetic pulse of ions injected into a plasma and by a calculation of the t-D reaction probability when high-energy tritons are injected into a deuterium plasma. (auth)

14848 TRANSMISSION OF A PLASMA JET ACROSS A MAGNETIC BARRIER. P. Lecoustey (CEA, Fontenay-aux-Roses, France). J. Nucl. Energy, Pt. C, 6: 81-4(Jan.-Feb. 1964). (In French)

The reflection rates at a magnetic mirror were calculated in terms of flux and transverse energy as a function of mirror ratio, using a simple model that considered only deuterons and two more elaborate models that take account of deuterons and electrons. (D.C.W.)

14849 ELEMENTARY PARTICLES. José M. Vidal Llenas. Mem. Real Acad. Cienc. Artes Barcelona, 34: 227-43(Dec. 1962). (In Spanish)

The present understanding of the ultimate constituents of matter is summarized. The particles and their properties are given. Classification and interactions of the particles are discussed, together with the associated conservation laws and nucleonic structure. (D.C.W.)

14850 ELEMENTARY PARTICLES AND THE SIGNATURE OF THE SPACE-TIME METRIC. G. Stephenson (Imperial Coll. of Science and Tech., London). Nature, 201: 589-90(Feb. 8, 1964).

The determination of properties of elementary particles, considered as singularities in the field, is considered using a special relativistic model and + 4 as the signature of the metric from the Lorentz transformations of special relativity. (R.E.U.)

14851 INELASTIC SCATTERING OF FAST NEUTRONS. L. N. Yurova and N. V. Kozlova. Nekotorye Vopr. Inzh. Fiz., No. 4, 59-90(1963). (In Russian)

Differential inelastic scattering cross sections were measured for several elements, using the $D(d,n)He^3$ reaction to obtain 2.5-Mev neutrons. Most of the experiments utilized neutrons emitted at 90° to the deuteron beam. Conical scatterers were placed near nuclear emulsions, and an identical set of emulsions was placed on the opposite side of the neutron source for background measurements. Scatterers of Mg, Ni, Cu, Zr, Pb, and Bi were used and the results compared to those of other experimenters using other techniques such as the spherical-shell scatterer technique. There was good general agreement with other workers for Mg, Ni, and Cu, while for Bi and Pb, the results agreed with several researchers and disagreed with a few others. An extensive tabulation of results of other workers is given. (TTT)

14852 ORDER OUT OF SUB-NUCLEAR CHAOS. P. T. Matthews (Imperial Coll. of Science and Tech., London). New Scientist, 21: 458-60(Feb. 20, 1964).

Recent discoveries and theories of "elementary particles" are discussed. The implications of the predicted omega minus are discussed. (R.E.U.)

14853 THE PHOTO-PRODUCTION OF π^+-MESONS FROM PROTONS. J. Kirk and J. McElroy (Univ. of Glasgow). Nuovo Cimento (10), 31: 705-15(Feb. 16, 1964).

The photoproduction reaction $\gamma + p \rightarrow n + \pi^+$ was studied using the nuclear emulsion technique and a high-pressure hydrogen gas target. The differential cross section was measured at six photon energies from 170 to 220 Mev in the laboratory system and at angles between 20 and 160° in the center-of-mass system. Angular distributions are presented and also the energy-dependence of the α_0^+ coefficient. General agreement is found with previous data. (auth)

14854 INTERACTIONS OF NEGATIVE K-MESONS IN NUCLEAR EMULSION AT ENERGIES (0 + 180) Mev. B. Bhowmik, D. P. Goyal, P. C. Jain, and P. C. Mathur (Univ. of Delhi). Nuovo Cimento (10), 31: 716-28(Feb. 16, 1964).

Analyses of 384 K^--meson interactions with complex nuclei of the emulsion, obtained by following 102.93 meters of K^- track length, are presented. The average mean free path in the energy interval 30 to 180 Mev is found to be (26.82 ± 1.39) cm. The variation of the interaction mean free path with K^- energy is discussed. A study of K^- inelastic scattering from emulsion nuclei was made and it is concluded that the nuclear potential for K^--mesons is strongly attractive. The energy spectra of charged pions and hyperons emitted from K^- interactions at these energies are discussed. It is shown that with increasing energy of the K^--meson the fractions, π^-/π^+ and Σ^-/Σ^+, also increase. The rates for various K^--single nucleon reactions were determined. A comparison of these rates at different K^- energies shows an enhancement in the direct Λ^0 production. (auth)

14855 π^-p INTERACTIONS AT 4.0 Gev/c. II. TWO-PRONG EVENTS. L. Bondár (Technische Hochschule, Aachen), K. Bongartz, M. Deutschmann, et al. Nuovo Cimento (10), 31: 729-47(Feb. 16, 1964).

A bubble chamber investigation of π^-p interactions was carried out at 4 Bev/c. Analysis is limited to 3828 events with two charged secondaries. Cross sections, angular distributions, and momentum distributions for the different reactions are presented. Four-momentum transfer distributions for elastic scattering and single-pion production are discussed. The production of pion resonance states is investigated. (auth)

14856 PAIR PRODUCTION IN HYDROGEN AND THE PANOFSKY RATIO. S. D. Warshaw (Argonne National Lab., Ill.), and S. Courtenay Wright. Nuovo Cimento (10), 31: 756-63(Feb. 16, 1964).

Observations are reported of 1600 pair- and triplet-production events in which the conversion occurs in the hydrogen filling of a 10-inch bubble chamber. The gamma rays responsible for the events are all identified as originating from charge-exchange and radiative-capture reactions of π-mesons stopping in the same bubble chamber. The number of π^- stops, the number of pairs and triplets separated as to source, along with a Monte Carlo calculation of geometrical factors, allows a determination of the Panofsky ratio and the constant A_{trip} in the assumed form of the triplet cross section $\sigma_{trip} = (28/9) \ln (2E_\gamma/m_e) - A_{trip}$. The results are $P = 1.590 \pm 0.089$ for the Panofsky ratio and $A_{trip} = (109 \pm 5.4)/9$. The best theoretical estimate for A_{trip} is 105/9 with an uncertainty of about 5/9. (auth)

14857 PERIPHERAL COLLISIONS AT ULTRA-HIGH ENERGIES. P. L. Jain (State Univ. of New York, Buffalo). Nuovo Cimento (10), 31: 764-71(Feb. 16, 1964).

The "effective target-mass" distribution in nucleon-nucleon interactions was obtained for a sample of 18 events of primary energy $\sim 10^{12}$ ev where the data on the momenta of almost all the shower particles were known. A method was also devised, for ultra-high-energy nucleon jets, to calculate approximately the effective target-mass from the angular distribution of the shower particles. In both cases the effective target-mass distribution indicates the pre-

dominance of interactions of the incoming nucleon with an effective mass close to a π-meson. (auth)

14858 K^--PROTON, K_2^0-PROTON, K^--DEUTERIUM SCATTERING AND ABSORPTION PROCESSES, AND 1405 Mev Y_0^*-RESONANCE. Ramesh Chand (Syracuse Univ., N. Y.). Nuovo Cimento (10), 31: 827-57(Feb. 16, 1964).

In order to describe the low-energy K^--p, K_2^0-p, and K^--d interactions, six new sets of energy-dependent s-wave $\overline{K}$-nucleon interaction parameters solutions are constructed as functions of the width of the 1405-Mev Y_0^*-resonance, by linear interpolations between Ross and Humphrey's amplitudes at low values of K^--momentum, Watson's amplitudes at 400 Mev/c, and by requiring the Y_0^*-resonance to be an s-wave bound state of the $\overline{K}$-nucleon system. It is found that the K^--p and K^--d scattering processes are rather insensitive to the width of Y_0^*, whereas the Σ-hyperons production cross sections favor 50 Mev for Y_0^* width. Also, it is observed that the contribution of Y_0^*-resonance to the at rest K^--d capture rates is within the uncertainties of experimental measurements (<20%). (auth)

14859 ON THE CONSERVED AXIAL-VECTOR CURRENT IN β-DECAY. V. S. Mathur, Ravinder Nath, and R. P. Saxena (Univ. of Delhi). Nuovo Cimento (10), 31: 874-8(Feb. 16, 1964).

The connection between nonrenormalization and conservation of an axial-vector current in β-decay is investigated. A simple Ward's identity is derived, and it is concluded that the Gamow-Teller coupling constant for a conserved axial-vector current remains unrenormalized. (auth)

14860 THE RELATIVISTIC LIMIT OF THE THEORY OF VECTOR MESONS. F. Strocchi (Università, Pisa, Italy). Nuovo Cimento (10), 31: 884-9(Feb. 16, 1964).

The analog of the Cini-Touschek transformation (relativistic limit) in the case of vector mesons is considered. The spinor form of the Maxwell equations is obtained after this transformation is performed. (auth)

14861 WEAK INTERACTION CURRENT AND THE UNITARY GROUP. A. Gaffur (Middle East Technical Univ., Ankara). Nuovo Cimento (10), 31: 914-17(Feb. 16, 1964).

A unified description is presented of the decay modes of mesons having $\Delta I = \frac{1}{2}, \frac{3}{2}$ or $\Delta S = \pm\Delta Q$ rules. The weight diagram of $D^{10}(3,0)$ in SU(3) is given. (R.E.U.)

14862 f_0-MESON AND PHOTON-PROTON SCATTERING. S. K. Kundu (Australian National Univ., Canberra). Nuovo Cimento (10), 31: 918-21(Feb. 16, 1964).

The effects of the f_0-meson on photon-proton scattering were analyzed. It is shown that the effect is not negligible as the large mass (1250 Mev) indicates. (R.E.U.)

14863 Λ^0 PRODUCTION BY K^--MESON IN PROPANE FROM 300 TO 1150 Mev/c. V. Bisi, G. Borreani, B. Quassiati, G. Rinaudo, and A. Werbrouck (Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 31: 922-4 (Feb. 16, 1964).

The production cross sections were measured for Λ^0 produced by K^- interactions with protons and carbon nuclei at 300 to 1150 Mev/c. Photographs were studied of a propane bubble chamber exposed to a beam of 1.15 Bev/c K^--mesons. (R.E.U.)

14864 ON A MODEL FOR HIGH-ENERGY SCATTERING. R. Oehme (Imperial Coll. of Science and Tech., London). Phys. Letters, 8: 201-3(Feb. 1, 1964).

The implications of a model for pp and $\bar{p}\bar{p}$ scattering based on the observation that strong singular forces in small dimensions give rise to fixed dynamical branch cuts in the complex angular momentum plane are discussed. (R.E.U.)

14865 IMPROVED BRANCHING RATIO FOR $\omega^0 \to \pi^+ \pi^-/\pi^+ \pi^- \pi^0$. W. D. Walker, J. Boyd, A. R. Erwin, P. H. Satterblom, M. A. Thompson, and E. West (Univ. of Wisconsin, Madison). Phys. Letters, 8: 208-10(Feb. 1, 1964).

Data for several two- and four-prong events produced by π^--p interactions at 2.1 Bev/c were analyzed to show the effect of ω^0. The cross section and branching ratio for ω^0 are obtained. (R.E.U.)

14866 BOSON DECAY PROBABILITIES AND UNITARY SYMMETRY. C. H. Chan (Middle East Tech. Univ., Ankara). Phys. Letters, 8: 211-13(Feb. 1, 1964).

Unitary symmetry was used in calculating 14 different decay modes of ρ, K^+, φ, ω, η, and π^0 particles. 16 references. (R.E.U.)

14867 A SCHEMATIC MODEL OF BARYONS AND MESONS. M. Gell-Mann (California Inst. of Tech., Pasadena). Phys. Letters, 8: 214-15(Feb. 1, 1964).

The bootstrap model for strongly interacting particles described in terms of the broken eightfold way is discussed to determine algebraic properties of the interactions with scattering amplitudes on the mass shell. A mathematical model based on field theory is described. (R.E.U.)

14868 THE ELECTROMAGNETIC FORM FACTOR OF THE NEUTRINO. Ph. Meyer and D. Schiff (Faculté des Sciences, Orsay, France). Phys. Letters, 8: 217-19 (Feb. 1, 1964).

The electromagnetic form factor of the neutrino was considered assuming that the weak interactions are mediated by charged vector bosons with no anomalous magnetic moment. (R.E.U.)

14869 ANALYSIS OF THE 50-Mev PROTON-PROTON SCATTERING DATA. Peter Signell, N. R. Yoder, and N. M. Miskovsky (Pennsylvania State Univ., University Park). Phys. Rev., 133: B1495-9(Mar. 23, 1964).

Phase-shift analyses were made of 25 pieces of pp data at 51.8 Mev, including σ, P, D, C_{NN}, and C_{KP}. The higher angular momentum phases were taken to be (i) one-pion exchange only (OPE) and (ii) Amati-Leader-Vitale (ALV) one-, two-, and three-pion exchange. χ^2 was lower than its expected value for both, with ALV slightly better than OPE. Standard deviations were obtained for the phase shifts and for the predicted pion-nucleon coupling constant. The solutions found were discrete, with no other in the neighborhood of the Type No. 1. The relative importance of each of the several kinds of data was examined, with a view to future experiments. (auth)

14870 VECTOR MESON DECAYS IN UNITARY SYMMETRY. K. Tanaka (Argonne National Lab., Ill.). Phys. Rev., 133: B1509-13(Mar. 23, 1964).

The relations among the amplitudes for the decays of a vector meson into two pseudoscalar mesons and a photon and among those for decays into two pseudoscalar mesons and N photons are derived by means of a convenient method based on the symmetry properties of the Lagrangian. These derivations are preceded by the rederivations of the relations among the amplitudes for the decays of a vector meson into two pseudoscalar mesons and among those for the decays into a pseudoscalar meson and N photons. (auth)

14871 SEARCH FOR AN INTERMEDIATE BOSON. J. V. Allaby, B. Gittelman, R. Prepost, D. M. Ritson, D. H. Coward, and B. Richter (Stanford Univ., Calif.). Phys. Rev., 133: B1514-15(Mar. 23, 1964).

In an experiment to observe the possible effects of an intermediate boson, the cross section for elastic electron-proton scattering was measured at 135° in the laboratory system for incident electron energies from 150 to 850 Mev. This energy range was covered in steps of 0.7% with an energy-analyzed electron beam 1% wide. The presence of the intermediate boson would have produced an enhancement in the cross section of from 50 to 500% at the resonance energy. The cross section at each energy was measured to a statistical precision of 3%. No resonant peak was observed in this energy range. The conclusion is that there is no evidence for such a boson of mass less than 3080 m_e. (auth)

14872 SYSTEMATIC APPROXIMATIONS FOR THE SINGLE-CHANNEL SCATTERING AMPLITUDE. F. Coester (Argonne National Lab., Ill.). Phys. Rev., 133: B1516-19(Mar. 23, 1964).

The scattering amplitude for two-particle single-channel scattering may be computed by inverting a Hilbert-space operator 1−K, where K is completely continuous and depends on the real energy as a parameter. This inversion can always be accomplished by obtaining a finite number of eigenvalues and eigenfunctions of K together with a modified Born expansion that is guaranteed to converge. Another method consists in the inversion of a finite matrix, the elements of which are computed by a convergent perturbation series. (auth)

14873 π-π SCATTERING WITH UNITARITY AND CROSSING. R. E. Kreps, L. F. Cook, J. J. Brehm, and R. Blankenbecler (Princeton Univ., N. J.). Phys. Rev., 133: B1526-43(Mar. 23, 1964).

A model of pion-pion scattering is presented in which each partial-wave amplitude in the s channel satisfies unitarity including inelastic states. This is accomplished by the use of the N/D technique. The full amplitude, i.e., the explicit, continued, partial-wave sum does not satisfy unitarity in the t and u channels, but it does have the correct branch points in these channels. These characteristics are guaranteed by construction and do not depend on arbitrary parameters occurring in the N functions. The parameters are fixed by imposing the crossing relations and by demanding the existence of a Pomeranchuk trajectory in the T = 0 channel. The existence of the ρ is not assumed. Since crossing is not satisfied exactly, the parameters are determined as those that yield the best fit to the crossing relations. Once the parameters are fixed, the behavior of each partial wave in each isospin channel is determined. Phase shifts are presented for the S, P, and D waves. The P wave is repulsive at low energies but becomes quite attractive at higher energies due to inelastic effects. A resonance occurs at $s = 33.7\mu^2$ with a width about three times that experimentally observed; this width is extremely sensitive to the parameters, the position is not. An S-wave ghost occurs at $s = -57.1\ \mu^2$ (whose residue is zero) as well as the Pomeranchuk trajectory at s = 0. The S waves are strongly repulsive at low energies. In fact, they are so repulsive that rather broad peaks are produced in their cross sections near 400 Mev when the phase shifts pass through $-\pi/2$. The peak in the T = 0 channel may very well correspond to the Abashian, Booth, and Crowe (ABC) anomaly. There are no resonances in the D waves. In particular, the existence of an f_0 is incompatible with any choice of the parameters unless it is accompanied by another strong D-wave resonance at low energy, and even this possibility violates crossing badly. This may be due to a poor choice for the trial function. (auth)

14874 CROSSED GRAPHS IN THE FEINBERG-PAIS THEORY OF WEAK INTERACTIONS. H. M. Fried (New York Univ., New York). Phys. Rev., 133: B1562-4(Mar. 23, 1964).

A possible damping mechanism is suggested to prevent the occurrence of essential singularities, such as that found on the light cone by Bardakci, Bolsterli, and Suura, when finite order expansions of the irreducible Bethe-Salpeter amplitude are iterated in configuration space without prior regularization. An infinite number of irreducible Feynman graphs are considered and approximated by a "peratization" method; a simple example is found in which the light cone damping, obtained by Feinberg and Pais by summing over the regularized ladder graphs, is reproduced by this crossed graph method. (auth)

14875 ASYMPTOTIC BEHAVIOR OF PARTIAL-WAVE AMPLITUDES. R. Omnes (Univ. of California, Berkeley). Phys. Rev., 133: B1543-8(Mar. 23, 1964). (UCRL-11008)

The asymptotic behavior of partial-wave amplitudes, when the full scattering amplitude satisfies Mandelstam representation and has itself a Regge asymptotic behavior is determined for finite energies. Particular attention is paid to the behavior of the partial-wave-amplitude discontinuities on their cuts. They are shown to behave as $|t|^{\alpha(0)-1}$, where t is the energy squared and $\alpha(0)$ is the leading Regge-pole position at zero energy. This result removes an old-standing difficulty in the Chew-Mandelstam calculation of amplitudes and provides a precise justification of the nearest singularity technique. As an application, it is shown that no subtraction is necessary in partial-wave-amplitude dispersion relations at physical values of the angular momentum, even for the case of S waves. (auth)

14876 MODEL OF MESONS AND BARYONS BASED ON SU_3 SYMMETRY. Yasuo Hara (California Inst. of Tech., Pasadena). Phys. Rev., 133: B1565-74(Mar. 23, 1964).

A model of mesons and baryons that incorporates the octet scheme of SU_3 symmetry is constructed. In this model, the pseudoscalar mesons and a unitary singlet vector meson are regarded as bound states of baryons and antibaryons. This model is shown to be self-consistent and to explain the observed mass levels if we choose $\alpha_p \approx 3\beta_p$ and $\alpha_V = 0$, where α_p and β_p are the D- and F-coupling constants of the $B\bar{B}\pi$ Yukawa interaction, respectively, and α_V is the D-coupling constant of the $B\bar{B}V_8$ interaction. This set of coupling constants is shown to explain baryon resonances. The coupling of a unitary singlet vector meson with baryons is shown to be $\alpha\bar{B}^i[i\cos\theta\gamma_\mu V_\mu - (1/2m_B)\sin\theta\sigma_{\mu\nu}\partial_\nu V_\mu]B^i$ with $0<\theta\leq 40^0$. It is also shown that the vector meson octet V_8 cannot be regarded as a bound state of the $\bar{B}B$ system. (auth)

14877 POLES AND SHADOW POLES IN THE MANY-CHANNEL S MATRIX. R. J. Eden and J. R. Taylor (Cambridge Univ., Eng.). Phys. Rev., 133: B1575-80(Mar. 23, 1964).

The connection between the partial-wave S matrix on different Riemann sheets is obtained from unitarity and analyticity. Under the assumption that coupling between channels can be varied analytically, it is shown that a resonance pole or bound-state pole may lead also to "shadow poles" on other Riemann sheets. The existence of shadow poles is illustrated by a unitary resonance model based on a sum of Feynman diagrams. In general, the number of shadow poles that can be deduced from an observed resonance depends on the number of channels that still have a particular reso-

nance pole in the absence of coupling between channels. If the pole still appears in all channels, then shadow poles occur on every Riemann sheet; if it appears in only one channel, then shadow poles appear on half the sheets. If the resonance disappears in the absence of channel coupling, the method leads to no conclusions. In connection with the unitary symmetry scheme it is noted that the existence of shadow poles would permit a simple change-over from the separated poles of a resonance multiplet with broken symmetry to the coincident poles of the multiplet that must occur when the symmetry breaking interaction is switched off. (auth)

14878 PION-PROTON INTERACTION AT 4.13 Bev/c AND BACKWARD SCATTERING. Shigeo Minami (Louisiana State Univ., Baton Rouge). Phys. Rev., 133: B1581-4 (Mar. 23, 1964).

The experimental data for $\pi^- - p$ scattering at 4.13 Bev/c are analyzed. It is found that there is an upper limit for the backward peak owing to the unitarity of S matrix, and that in spite of the fact that the total elastic cross section comes almost entirely from the forward peak, the S matrix for the partial wave is markedly affected by the existence of a small backward peak. (auth)

14879 EXPERIMENTAL CONSEQUENCES OF ϕ-ω MIXING. Roger F. Dashen (California Inst. of Tech., Pasadena) and David H. Sharp. Phys. Rev., 133: B1585-8(Mar. 23, 1964).

A simple model is proposed in which the observed ϕ and ω resonant states are considered as mixtures of "pure" states $|Y\rangle$ and $|B\rangle$ corresponding to hypercharge and baryonic mesons. The implications of this model for the isoscalar nucleon form factor, the decays of the ϕ, ω, and π^0 mesons, the role of the ω and ϕ mesons in nuclear forces, the mass distribution of Dalitz pairs in the decay $\pi^0 \rightarrow \gamma + e^+ + e^-$, and the photoproduction of η mesons are briefly considered. (auth)

14880 POTENTIAL THEORY CALCULATIONS BY THE QUASIPARTICLE METHOD. M. Scadron and S. Weinberg (Univ. of California, Berkeley). Phys. Rev., 133: B1589-96(Mar. 23, 1964).

The quasiparticle method is used to find binding energies, scattering lengths, and cross sections for one particle in a strong Yukawa, Hulthén, or exponential potential. The results are excellent in the lowest approximation. (auth)

14881 CORRELATIONS IN $\bar{p}p \rightarrow 4\pi$. J. M. Shpiz (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 133: B1597-1606(Mar. 23, 1964).

Under the assumption that the $p\bar{p}$ annihilation takes place from an S state, the unique final state of $p\bar{p} \rightarrow 2\rho^0 \rightarrow 2\pi^+ + 2\pi^-$ was constructed within the formalism of Jacob and Wick. The mean value of $\cos\theta_{12}$ between pion pairs was computed and the results for annihilation at rest are $\langle\cos\theta_{12}^{++}\rangle = -0.29$ and $\langle\cos\theta_{12}^{+-}\rangle = -0.31$. The di-pion effective mass distributions were also computed. (auth)

14882 METHOD FOR THE SELF-CONSISTENT DETERMINATION OF REGGE POLE PARAMETERS. S. C. Frautschi (California Inst. of Tech., Pasadena), P. E. Kaus, and F. Zachariasen. Phys. Rev., 133: B1607-15(Mar. 23, 1964).

A method is suggested for approximately bootstrapping Regge trajectories, thereby avoiding the cutoff problems of the usual bootstrap calculation. The method is based on dispersion relations for Regge trajectories and on unitarity applied at $l = \alpha$. Successively more realistic approximations are described that bring in more information on the potential, and more trajectories. The approximate Regge parameters are guaranteed to have the desired threshold and asymptotic properties. (auth)

14883 SOME NON-BORN PHASE SHIFTS. Henry Brysk (Adelphi Univ., Garden City, N. Y.). Phys. Rev., 133: B1625-32(Mar. 23, 1964).

Over the past few years, there were a number of independent attempts to improve on the Born approximation calculation of scattering phase shifts. The similarity of several of the first-order results for central potentials has led to misconceptions as to their interrelationship. The interpretation of the approximations is now put on a firm basis (sometimes at variance with the previous literature). The alternatives in going to higher order are sorted out and their meaning is clarified. The extensions to non-central potentials are given. A numerical exploration of the precision of different higher order results was carried out. (auth)

14884 COMPARISON OF MODERATE ENERGY PROTON-PROTON MODELS. [PART] II. Peter Signell and N. R. Yoder (Pennsylvania State Univ., University Park). Phys. Rev., 134: B100-1(Apr. 13, 1964).

The published phases of Scotti and Wong, and of the Yale YLAM and YRBI representations, are compared to the 647 pieces of 10 to 320-Mev scattering data used in a previous comparison. A ten-parameter comparison representation for the phase shifts is found to fit the data about as well as most models, and considerably better than the Scotti-Wong phases. (auth)

14885 PSEUDOSCALAR CHARGE DENSITY OF SPIN-½ PARTICLES. I. EXISTENCE. K. Hiida (Argonne National Lab., Ill.). Phys. Rev., 134: B174-81(Apr. 13, 1964).

When interactions are renormalizable and are invariant under time reversal but not invariant under space reflection, then under the requirement that the S matrix is free from divergences after renormalization it is shown that any spin-½ particle with nonvanishing mass should have pseudoscalar charge density in addition to the usual scalar charge density. Unrenormalizable interactions are also discussed as possible sources of the pseudoscalar charge density. Arguments are given for the observability of the pseudoscalar charge density. (auth)

14886 PHOTOPRODUCTION OF K MESONS AT LOW ENERGY. Fayyazuddin (Atomic Energy Center, Lahore, Pakistan). Phys. Rev., 134: B182-7(Apr. 13, 1964).

Photoproduction of K mesons is considered at low energy so that only s and p waves are important. The contribution of Born terms, K* meson, and N* resonance is calculated for the reaction $\gamma + N \rightarrow K + Y$. The values of unknown parameters such as hyperon magnetic moments and relative strengths and signs of $g_{KN\Lambda}$, $g_{KN\Sigma}$, $g_{K^*N\Lambda}$, and $g_{K^*N\Sigma}$ coupling constants as given by the octet model of unitary symmetry, are used. A reasonable fit to the experimental data on angular distributions for the reactions $\gamma + p \rightarrow K^+ + \Lambda^0$ and $\gamma + p \rightarrow K^+ + \Sigma^0$ is obtained in this model. In the model odd $K\Lambda$ and even $\Lambda\Sigma$ parities are implied. Thus the difference in the angular distribution of $K^+\Lambda^0$ and $K^+\Sigma^0$ production can be explained for even $\Lambda\Sigma$ parity. Certain predictions for other reactions were obtained that can be tested experimentally when the data on these reactions will be available. (auth)

14887 BRANCHING RATIOS OF THE DECAY MODES $\Sigma^\pm \rightarrow n + e^\pm + \nu$. C. Thornton Murphy (Univ. of Wisconsin, Madison). Phys. Rev., 134: B188-97(Apr. 13, 1964).

A search was made for examples of the beta-decay mode of the sigma hyperon, $\Sigma^\pm \rightarrow n + e^\pm + \nu$, among a large sample of sigmas produced by stopped K^- mesons in a propane-

freon bubble chamber. A total of 23,000 negatively charged sigmas and 17,000 positively charged sigmas were observed, which decayed via the charged π mode, $\Sigma^{\pm} \rightarrow n + \pi^{\pm}$. An electron track was distinguished from that of a π meson by the observation that the track curled up in the chamber, or curved too much, or produced a δ ray with too high an energy to have been produced by a π from a sigma decay. No Σ_{β}^{+} decays, which are thought to be forbidden by the $\Delta S = \Delta Q$ rule, were found. A total of 11 Σ_{β}^{-} decays were found. The branching ratio for Σ_{β}^{-} decay, $\Gamma(\Sigma^{-} \rightarrow n + e^{-} + \nu)/\Gamma(\Sigma^{-} \rightarrow n + \pi^{-})$, was found to be 1.0×10^{-3}. The upper limit of the ratio of the Σ_{β}^{+} decay rate to the Σ_{β}^{-} decay rate, $\Gamma(\Sigma^{+} \rightarrow n + e^{+} + \nu)/\Gamma(\Sigma^{-} \rightarrow n + e^{-} + \nu)$, determined in the experiment was 0.4. (auth)

14888 MULTIPLE-PION PRODUCTION BY 2-Bev π^{-}. P. H. Satterblom, W. D. Walker, and A. R. Erwin (Univ. of Wisconsin, Madison). Phys. Rev., 134: B207-27(Apr. 13, 1964).

A report is given of a study of pion-proton interactions in a liquid-hydrogen bubble chamber. A 2.1-Bev/c negative pion beam incident upon a 14-in.-diam chamber caused interactions from which those with four charged secondaries were selected and measured. Fits were attempted to the following final states: $3\pi + p$, $3\pi + p + \pi^{0}$, and $4\pi + n$. By normalizing to a total cross section of 35.7 mb, the partial cross sections for the above-listed final states are found to be 1.67 ± 0.08, 1.17 ± 0.06, and 0.37 ± 0.02 mb. The $3\pi + p$ reaction was found to be dominated by the production of the $\frac{3}{2}-\frac{3}{2}$ pion-nucleon isobar. The cross section for this process is 0.53 ± 0.05 mb. Evidence for the eta and omega mesons was found in the $3\pi + p + \pi^{0}$ final state. Their cross sections are 0.037 ± 0.015 and 0.26 ± 0.035 mb, respectively. A Dalitz plot for eta decays is presented. Evidence is given for a double peak in the neutral two-pion mass spectrum for $3\pi + p$ and $4\pi + n$ events. The peaks coincide with those attributed to the rho meson in other experiments. The second of the two peaks corresponds well with the mass of the ω^{0}. A branching ratio of $(\omega^{0} \rightarrow 2\pi)/(\omega^{0} \rightarrow 3\pi)$ is found to be >0.1. An attempt is made to calculate the pion-pion cross section by isolating events with low momentum transfer to the isobar. In the various processes, enhancement is found in the nucleon $+2\pi$ mass spectra corresponding to the $T = \frac{3}{2}$ state of mass 1920 Mev. It is proposed that the elementary cross diagram can explain these effects. (auth)

14889 MEASUREMENTS OF THE $\pi^{+}p \rightarrow \pi^{+}p\pi^{0}$ CROSS SECTION FROM 0.5 TO 1.5 Gev/c. J. F. Detoeuf, Y. Ducros, J. P. Merlo, A. Stirling, B. Thevenet, L. van Rossum, and J. Zsembery (CEN, Saclay, France). Phys. Rev., 134: B228-35(Apr. 13, 1964).

The cross section for $\pi^{+}p \rightarrow \pi^{+}\pi^{0}p$ was measured for meson (π^{-}) energies from 0.5 to 1.5 Bev/c. This cross section increases rapidly between 600 and 900 Mev/c to reach 10 mb. Using the results, the $\pi^{+}p \rightarrow \pi^{+}\pi^{+}n$ cross section was calculated. (auth)

14890 ELECTROMAGNETIC VIOLATION OF CONSERVATION OF VECTOR CURRENT. Riazuddin (Univ. of Rochester, N. Y.). Phys. Rev., 134: B235-9(Apr. 13, 1964). (UR-875-16)

The electromagnetic violation of vector current conservation is considered and the strong interaction renormalization of the β-decay coupling constant G_V in the presence of electromagnetism is estimated. It is shown that the existing discrepancy between the G_V and the μ-decay coupling constant G_{μ} may be due to such a renormalization. Use is made of a hypothetical scalar particle with isotopic spin unity. This particle was used as an auxiliary means and the final results do not depend on the parameters of such a particle. It is shown that this particle has interactions with other particles only if the electromagnetic mass splitting of the isotopic multiplets is not neglected. Other properties of this particle are discussed. (auth)

14891 PROTON-PROTON SCATTERING AT 16.7 Bev/c AND INTERACTION WITH THE NUCLEON CORE. Shigeo Minami (Louisiana State Univ., Baton Rouge). Phys. Rev. Letters, 12: 200-3(Feb. 24, 1964).

The effects of Fermi statistics are used to determine the differential cross section for proton-proton interactions at 16.7 Bev/c. The contribution to the diffraction peak height from a core term is considered. (R.E.U.)

14892 OBSERVATION OF A HYPERON WITH STRANGENESS MINUS THREE. V. E. Barnes, P. L. Connolly, D. J. Crennell, et al. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 12: 204-6(Feb. 24, 1964).

An observation of an event believed to be the production and decay of the 1680-Mev/c^2 Ω^{-} particle is reported. The event was produced by a 5.0-Bev/c K^{-} meson beam in the BNL 80-in hydrogen bubble chamber. Implications of its discovery are discussed. (R.E.U.)

14893 REGGE-POLE MODEL FOR HIGH-ENERGY pp AND $\bar{p}p$ SCATTERING. William Rarita (Univ. of California, Berkeley) and Vigdor L. Teplitz. Phys. Rev. Letters, 12: 206-8(Feb. 24, 1964).

The larger cross section for $\bar{p}p$ than pp is associated with a narrower diffraction peak. A Regge-pole model for high-energy scattering is used to resolve this. (R.E.U.)

14894 ASYMPTOTIC BEHAVIOR OF ELECTROMAGNETIC FORM FACTORS. A. P. Balachandran, Peter G. O. Freund, and Clifford R. Schumacher (Univ. of Chicago). Phys. Rev. Letters, 12: 209-11(Feb. 24, 1964).

The strong asymptotic decrease of electromagnetic form factors observed in high-energy electron-proton scattering is discussed. The existence of an I = 1 vector meson with mass between 750 and 1360 Mev is seen to be a consequence of resonance domination of form factors. (R.E.U.)

14895 POLARIZATION IN THE ELASTIC SCATTERING OF 22-Mev PROTONS FROM DEUTERONS. H. E. Conzett (Univ. of California, Berkeley), G. Igo, and W. J. Knox. Phys. Rev. Letters, 12: 222-5(Mar. 2, 1964). (UCRL-10586)

The measurement and interpretation of polarization data from low-energy scattering are discussed. (R.E.U.)

14896 SECONDARY DIFFRACTION PEAK IN PION-NUCLEON SCATTERING. L. M. Simmons (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 12: 229-31(Mar. 2, 1964).

An optical model is shown to explain a second maximum in the $\pi^{\pm}p$ elastic scattering total cross section as a secondary diffraction peak. (R.E.U.)

14897 NUCLEON ELECTROMAGNETIC FORM FACTORS AT HIGH MOMENTUM TRANSFER. Robert G. Sachs (Univ. of Wisconsin, Madison). Phys. Rev. Letters, 12: 231-3(Mar. 2, 1964). (TID-20099)

It is shown that there is no necessary contradiction in results leading to the conclusions that the nucleon is fundamental rather than composite and that there is no core contribution to the proton form factors. (R.E.U.)

14898 MUON POLARIZATION IN $K_{\mu 3}^{+}$ DECAY. V. A. Smirnitski and A. O. Weissenberg (Inst. for Experimental

and Theoretical Physics, Moscow). Phys. Rev. Letters, 12: 233-6(Mar. 2, 1964).

The meson (μ^+) polarization was measured from the asymmetry of $\mu^+ \rightarrow e^+$ decay angular distribution. Form factor ratios were studied, and results of previous investigations are summarized. (R.E.U.)

14899 A NINTH BARYON? Julian Schwinger (Harvard Univ., Cambridge, Mass.). Phys. Rev. Letters, 12: 237-9 (Mar. 2, 1964).

Results of calculations based on a new field theory of matter are presented. The theory utilizes an analogy between nucleonic charge and electric charge. Predictions of these calculations are discussed. (R.E.U.)

14900 TEST FOR THE SPIN AND PARITY OF FOUR-MESON RESONANCES. Francis R. Halpern (Univ. of California, San Diego, La Jolla). Phys. Rev. Letters, 12: 252-3(Mar. 9, 1964).

A test is suggested to determine the spin and parity of the four-meson B resonance in π^+p interactions. The B decays into a π-meson and an ω-meson, and then the ω decays into three additional π-mesons. (R.E.U.)

14901 STUDY OF THE SPIN AND PARITY OF THE B MESON. D. Duane Carmony, Richard L. Lander, Carl Rindfleisch, Nguyen-huu Xuong, and P. Yager (Univ. of California, San Diego, La Jolla). Phys. Rev. Letters, 12: 254-6(Mar. 9, 1964).

A study of the spin and parity of the $\pi\omega$ resonance at 1220 Mev is presented. An assignment of 1^- is favored. (R.E.U.)

14902 HIGH-ENERGY p-p ELASTIC SCATTERING. Toichiro Kinoshita (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 12: 257-9(Mar. 9, 1964).

The energy and angular distribution of the elastic cross section are shown to follow an exponential formula at all nonforward and nonbackward angles except 90°. Elastic p−p scattering at minimum amplitude is discussed. (R.E.U.)

14903 EXCITED STATES OF BARYONS. P. Carruthers (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 12: 259-62(Mar. 9, 1964).

A model for higher resonances in meson (π)-nucleon scattering is generalized to baryon-pseudoscalar meson scattering. Unitary symmetry provides octet membership for the baryons and mesons interacting through forces invariant under the SU(3) transformations. Regge recurrences of the baryon octet and a $P_{\frac{3}{2}}$ decuplet are predicted. (R.E.U.)

14904 NEUTRINO INTERACTIONS AND A UNITARY UNIVERSAL MODEL. M. M. Block (Northwestern Univ., Evanston, Ill.). Phys. Rev. Letters, 12: 262-5(Mar. 9, 1964).

Predictions of neutrino and antineutrino reactions at 1 to 2 Bev/c are given. Proposed tests for selection rules $\Delta S = \Delta Q$, $\Delta I = \frac{1}{2}$ for $\Delta S = +\Delta Q$, $\Delta I = 1$ for $\Delta S = 0$, and $\Delta S = 2$, are suggested using neutrino beams. (R.E.U.)

14905 DOES SPONTANEOUS BREAKDOWN OF SYMMETRY IMPLY ZERO-MASS PARTICLES? Abraham Klein and Benjamin W. Lee (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Letters, 12: 266-8(Mar. 9, 1964).

The implication of massless bosons from a proof by Goldstone, Salam, and Weinberg is shown to have a nonrelativistic analog that yields a massless boson excitation independent of model used. The operators and the invariance property relevant to the theory of superconductivity are used explicitly. It is concluded that there exists no general proof, independent of model and method of calculation, that establishes the existence of zero-mass particles in field theories with spontaneous breakdown of symmetry, but there are nevertheless classes of field theories wherein zero-mass particles occur in consequence of the broken symmetry. (R.E.U.)

14906 MEASUREMENT OF THE DEUTERON MAGNETIC FORM FACTOR AT LOW MOMENTUM TRANSFER. J. Goldemberg and C. Schaerf (Stanford Univ., Calif.). Phys. Rev. Letters, 12: 298-300(Mar. 16, 1964).

The ratio of the elastic electron-proton and electron-deuteron scattering was measured at 180° for momentum transfers of 0.26 and 0.41 f^{-2} to establish a form factor dependence on momentum transfer. Theoretical values of the magnetic form factor of the deuteron were calculated from a nonrelativistic expression using the deuteron wave functions with the D-state probability in the deuteron ground state $P_D = 0.07$. The deuteron magnetic moment and form factors are plotted as functions of momentum transfer. (R.E.U.)

14907 SOLAR NEUTRINOS. I. THEORETICAL. John N. Bahcall (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 12: 300-2(Mar. 16, 1964).

The number of absorptions of solar neutrinos per terrestrial Cl^{37} atom is predicted by combining theoretical flux calculations and cross sections for the reaction (Q = −0.81 Mev) $Cl^{37}(\nu_{solar}, e^-)Ar^{37}$. The role of Li^4 in the proton-proton chain of the sun is discussed. (R.E.U.)

14908 SOLAR NEUTRINOS. II. EXPERIMENTAL. Raymond Davis, Jr. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 12: 303-5(Mar. 16, 1964). (BNL-7660)

A method is described for observing solar neutrinos from the reaction $Cl^{37}(\nu, e^-)Ar^{37}$ in C_2Cl_4. Two 500-gal tanks of C_2Cl_4 were placed in a limestone mine (1800 m.w.e.) and the resulting Ar^{37} activity induced by cosmic mesons(μ) was measured to determine the necessary conditions for solar neutrino observations. (R.E.U.)

14909 3-PION DECAY OF THE INTERMEDIATE-VECTOR BOSON. Mirza A. B. Bég, John M. Cornwall, and Ching-Hung Woo (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Letters, 12: 305-7(Mar. 16, 1964).

The $W\rho\pi$ coupling constant is obtained from di-pion considerations of the $W \rightarrow \pi\sigma$. The decay rates are given for summing over both charge modes and for summing over the electron and muon modes. (R.E.U.)

14910 SCALAR DI-PION RESONANCE AND THE NUCLEON AXIAL FORM FACTOR. Ching-Hung Woo (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Letters, 12: 308-10(Mar. 16, 1964).

It is shown that the inclusion of a scalar dipion resonance (395 ± 10 Mev) can improve the agreement between theoretical and experimental information on the nucleon axial form factor. (R.E.U.)

14911 STUDY OF $\pi^-\pi^+$ SYSTEM IN $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ REACTION. M. M. Islam and R. Piñon (Brown Univ., Providence). Phys. Rev. Letters, 12: 310-13(Mar. 16, 1964).

The $\pi^-\pi^+$ system was studied in the reaction $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ in the Bev region. The production of ω by ρ exchange is considered, the ρ is produced through single-pion exchange and decays into $\pi^-\pi^+$, as does the ω. The center-of-mass distribution of $\pi^-\pi^+$ in the ρ-resonance region is discussed. (R.E.U.)

14912 QUANTUM ELECTRODYNAMICS WITH ZERO BARE FERMION MASS. Th. A. J. Maris, Victoria E. Herscovitz, and Gerhard Jacob (Universidade do Rio Grande do Sul, Porto Alegre, Brazil). Phys. Rev. Letters, 12: 313-15(Mar. 16, 1964).

The logarithmic divergence of the fermion self-mass in lowest order perturbation theory of quantum electrodynamics is shown to disappear if the approximation is sufficiently improved and the bare fermion mass is assumed to be zero. Some features of the dilatationally invariant theory are discussed. (R.E.U.)

14913 INTRODUCTION TO THE STRUCTURE ANALYSIS OF COLLISION AMPLITUDES. R. J. Eden. Progr. Nucl. Phys., 9: 117-54(1964).

The methods of location of singularities of functions of one or more complex variables (structure analysis) for collision amplitudes, which are functions of Lorentz invariants that are related to the energy of colliding particles and to scattering angles, are discussed for elementary particle-physics. The problem of structure analysis is approached using axiomatic quantum field theory, perturbation theory, heuristic methods and approximations about analyticity, or phenomenology and the study of experimental results. A mathematical introduction to dispersion relations, potential scattering, Feynman diagrams, and resonance approximations is presented. Form factors for scalar particles, scattering of equal-mass particles, unitarity and equations for partial wave amplitudes, pion-nucleon scattering, and asymptotic behavior of amplitudes are discussed. 132 references. (R.E.U.)

14914 ELECTROMAGNETIC PROPERTIES OF THE MUON. F. J. M. Farley (CERN, Geneva). Progr. Nucl. Phys., 9: 257-93(1964).

Properties considered include mass, spin, charge, magnetic moment, and electric dipole moment a low energy, and at high energy the form factors. Experiments used to determine the properties are discussed. 130 references. (R.E.U.)

14915 NOTE ON THE STRANGENESS CONSERVING β-DECAYS OF $\Sigma^{\pm}$-HYPERONS $\Sigma^{\pm} \rightarrow \Lambda + e^{\pm} + N$. Yoshio Yamaguchi (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 30: 836-9(Dec. 1963).

Strangeness conserving β-decays of the Σ hyperons are discussed. Their partial decay rates are known to be smaller than those predicted by universality. It is noticed that this fact is more consistent with the Goldhaber picture of hyperons than other possibilities. (auth)

14916 BOSON LEVELS AND COMPOSITE MODEL. Shin-ya Furui (Ibaraki Univ., Mito, Japan), Susumu Furuichi, Shin Ishida, Shoichiro Kawasaki, and Makoto Sawamura. Progr. Theoret. Phys. (Kyoto), 30: 840-71(Dec. 1963).

Boson levels are investigated dynamically from the viewpoint of the symmetrical Sakata model. It is assumed that almost all of the observed bosons are the bound states of a baryon-antibaryon pair. The problem is formulated by the N/D method in a modified form. The consequences about the mass spectrum which are derived irrespectively of the mass difference Δm between nucleon and Λ, are that there exist no other octet bosons than π-octet and ρ-octet bosons, there are bound states in unitary singlet $^3P_0$ state (ABC-particle) and in $^3S_1$ state (φ-particle), and the existence of a unitary singlet $^1S_0(0^{-+})$ composite particle is probable. Our theory can reproduce almost correctly the observed mass spectrum, when the mass difference between N and Λ is considered. Relations of our theory to the usual Yukawa coupling theory about the interaction of bosons and baryons are also investigated. It is shown that the coupling constant of pion to nucleon is correctly given independent of the details of our method. Comments on the properties of nuclear forces in the inner region are given. (auth)

14917 MECHANISM OF HIGH ENERGY INELASTIC COLLISION AND THE SHRINKAGE OF DIFFRACTION PEAK. Takeshi Kanki (Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 30: 872-8(Dec. 1963).

Two mechanisms of high-energy inelastic collisions are given, each of which causes an increase in the target radius and transparency. The mechanism of shrinkage in the diffraction peak of an elastic event or, in other words, the reason why the target radius can become infinity in the high energy limit, is clarified. (auth)

14918 STRANGE NEUTRINO AND A COMPOSITE MODEL FOR ELEMENTARY PARTICLE. [PART] II. Tadashi Ouchi and Kei Senba (Univ. of Hiroshima). Progr. Theoret. Phys. (Kyoto), 30: 887-95(Dec. 1963).

The nature of the vacuum-cloud is studied. It is shown that two neutrinos, ν_μ and ν_e, can be introduced in a natural way in a theory in which $\Delta S = \Delta Q$ is also violated. From the resonance data on the $(\pi^{\pm} + P)$ scattering experiment, the energy of vacuum cloud is found to be quantized along the lines of the old quantum theory. This is a new freedom concerning the vacuum cloud and plays a decisive role in deriving the mass formula for the particle and resonance. A new constant R_0, the Rydberg-like one, appearing in association with this quantization is determined to be $\sqrt{2}m(\pi^{\pm})g^4/(2\hbar^2) = 38.26$ Bev, where $g^2/e^2 = m(P)/m(e)$ is taken. (auth)

14919 STRANGE NEUTRINO AND A COMPOSITE MODEL FOR ELEMENTARY PARTICLE. [PART] III. Tadashi Ouchi, Kei Senba, and Akira Ohmae (Univ. of Hiroshima). Progr. Theoret. Phys. (Kyoto), 30: 896-910 (Dec. 1963).

The mass formulas for elementary particles and resonance states are presented on the basis of Ouchi-Senba's model of the composite particle and on the analogy of the old quantum theory. They are expressed in the form of the difference of two terms as the spectrum series of hydrogen atom. Agreement of the theoretical mass values with the experimental ones is fairly good and becomes almost complete when reasonable quantum defects (−0.12, +0.02, and −0.2) are introduced. The mass formulas are explicitly described for almost all particles and resonance states; μ, π, K, N, Λ, Σ, Ξ, K^*, Y^*, ω, ρ, η, ζ, and ABC. To explain the formulas, discrete stationary states of the vacuum cloud and a principle corresponding to Bohr's frequency rule in old quantum mechanics are postulated. (R.E.U.)

14920 SOME REMARKS ON PION DECAY. Yasusi Ataka (Univ. of Kumamoto, Japan). Progr. Theoret. Phys. (Kyoto), 30: 916-18(Dec. 1963).

The π-meson decay amplitude is calculated in the one-pair approximation with pseudoscalar meson coupling. (R.E.U.)

14921 RESONANT STATES IN THE MESON-FAMILY. Shigeo Minami (Louisiana State Univ., Baton Rouge, La.). Progr. Theoret. Phys. (Kyoto), 30: 922-4(Dec. 1963).

The selection rule for bound-state nucleon-antinucleon descriptions of resonant states is discussed. Predictions from considering the π, η, and $K(\bar{K})$ mesons as basic particles in resonant-state descriptions are considered. (R.E.U.)

14922 RELATION BETWEEN ANGULAR DISTRIBUTION OF SHOWER PARTICLES AND MOTION OF FIRE BALL. Takeshi Ogata (Kinki Univ., Osaka). Progr. Theoret. Phys. (Kyoto), 30: 924-6(Dec. 1963).

A dipole-type angular distribution of shower particles from multiple-meson-producing reactions is interpreted in terms of the finite angle of emission of a fire ball with isotropic emission of shower particles in the rest system of the fire ball. (R.E.U.)

14923 π-p COLLISIONS AT HIGH ENERGIES. N. N. Tsilosani. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 9: 67-75 (1963). (In Russian)

The method of Tomonag's intermediate bound when $\pi\pi$ interaction is taken into account is used for the process of an additional pion production in pion-nucleon collisions. (auth)

14924 SCATTERING OF π^+ MESONS ON HYDROGEN AND CARBON. R. G. Salukvadze and D. Niyagu. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 9: 85-95(1963). (In Russian)

Scattering of π^+-mesons with the energy of 78 Mev on hydrogen and carbon were studied in a small propane bubble chamber. The following total cross-sections are determined: of elastic π^+-p scattering $\sigma(\pi^+,p) = (38.84\text{-}5.95) \times 10^{-27}$ cm^2, of elastic and inelastic scattering of π^+-mesons on carbon nucleus $\sigma(\pi^+,C) = (166.0\text{-}13.6) \times 10^{-27}$ cm^2. (auth)

14925 THE PAULI-FIERZ TRANSFORMATION GROUP AND FOUR-FERMION INTERACTION LAGRANGIANS. A. Ainsaar, I. Ots, and H. Õiglane. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 22, 54-60(1963). (In Russian)

A group of transformations of four-fermion interaction lagrangians called the Pauli-Fierz group was defined. It proves to be isomorphic to the group of space-time reflections. The interaction lagrangians are treated as eigenvectors of the group operators. They are specified by the requirement that a certain kind of chirality should be assigned to one of the particles participating in the interaction. The lagrangians of the four-particle interaction are considered as vectors in a linear space, and their scalar products are defined. Relations between the coupling constants corresponding to the three types of lagrangians found (including the lagrangian of V–A type) are established by making use of the assumption that all the lagrangians have the same lengths. (auth)

14926 STRONG INTERACTIONS AT VERY HIGH ENERGIES. E. L. Feinberg and D. S. Chernavskii. Usp. Fiz. Nauk, 82: 3-81(Jan. 1964). (In Russian)

During recent years, studies of strong interactions at high-energy levels underwent several changes. Experiments were carried out at 1 to 3×10^{10} ev with accelerators and even beyond 10^{11} ev with cosmic rays. Among the theories developed, the theory of complex orbital moments or the Regge pole theory and the more rigorous one-meson approximation are considered; the latter represents a more sophisticated version of the Weizsäcker–Williams theory. Some of the main conclusions of the Regge pole theory were confirmed by proton-proton (p-p) scattering experiments carried out in the 10- to 20-Bev range. Although at one time the theory was viewed as having general validity in view of these experiments, more-recent studies indicated that this is not the case; results of π^--p interaction experiments, carried out after the p-p scattering tests, did not bear out the predictions of the theory. The one-meson approximation method is not applicable to all phenomena but was developed gradually to cover a limited set of experimental facts. Current work is directed toward establishing a connection between elastic and inelastic processes in the field of high-energy interactions. Considerable attention is devoted to the experiments with cosmic rays. Data are available in the 10^{11} to 10^{13} ev range and experiments are being carried up to the 10^{16} ev level. It was concluded that data on the interaction of high-energy particles cannot be explained on the basis of a single theory. (Review article, 127 refs.) (TTT)

14927 α-α SCATTERING AND PAULI PRINCIPLE. Hans W. Wittern (Florida State Univ., Tallahassee). Z. Naturforsch., 18a: 1254-65(Dec. 1963). (In German)

With regard to the Pauli principle and some general characteristics of 8-particle problems, an approximately valid reduction to a two-particle problem was undertaken and a potential derived, that correctly describes α-α scattering at least for low energies. (tr-auth)

14928 ELECTROMAGNETIC WAVE OBLIQUE DIFFRACTION ON A PLANE METALLIC LATTICE WITH A SCREEN AND MAGNETODIELECTRIC. A. I. Adonina and V. V. Shcherbak (Khar'kov State Univ.). Zh. Tekhn. Fiz., 34: 168-73(Jan. 1964). (In Russian)

The vector problem was resolved for oblique electromagnetic wave diffraction. The solution was attained using diffraction data for two heterogeneous adjoint functions resolved by Z. S. Agranovich et al. (Zh. Teoret Fiz. 32: v. 4, 1962). Reflection and amplitude factors for the diffraction spectra were determined without using limitations for the lattice constant, space factor, screen distance, dielectric penetrability, and length of incident wave. (tr-auth)

14929 EXPERIMENTAL STUDIES OF ELECTROMAGNETIC WAVE DIFFRACTION ON BINARY METAL LATTICES. A. V. Provalov, O. A. Tret'yakov, and V. P. Shestopalov. Zh. Tekhn. Fiz., 34: 186-8(Jan. 1964). (In Russian)

Electromagnetic wave diffraction on plane binary metallic lattices with arbitrary distance ratios between the lattice constants, arbitrary lattice filling factors, and constant wavelength relations not exceeding 2. The results of the experiment are in agreement with theory. (tr-auth)

14930 THEORY OF ELEMENTARY PARTICLES. Second Improved and Revised Edition. Paul Roman. From the Series in Physics. New York, Interscience Publishing, Inc., 1961. 593p.

The theory of elementary particles is reviewed, with attention to: the four-dimensional orthogonal group; field equations; field quantization; invariance properties and selection rules; and isobaric space. (T.F.H.)

14931 THE BOOTSTRAP METHOD IN THE PHYSICS OF STRONG INTERACTIONS. B. M. Udgaonkar (Argonne National Lab., Ill.). p.65-79 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

The development of simple calculational techniques that have made it possible to carry out the first reliable calculations of the positions and widths of some of the low-energy resonances and the realization that even the symmetries of strong interactions may be understood in a simple fashion by using the bootstrap method are discussed. The idea is illustrated by $\pi\pi$ scattering with the production of the meson (ρ). (C.E.S.)

14932 SOME EXPERIMENTAL PREDICTIONS FROM THE REGGE POLE HYPOTHESIS. H. Uberall (Univ. of Michigan, Ann Arbor). p.89-95 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

Experimental predictions from the Regge pole hypothesis concerning the differential forward cross section and polarization in π-p and K-p scattering, backward π-N scattering, and forward associated production are discussed. (C.E.S.)

14933 APPROACH TO EQUILIBRIUM IN STATISTICAL MECHANICS. N. M. Hugenholtz (State Univ. of Iowa, Iowa City). p.114-23 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

Macroscopic variables for describing equilibrium properties of a fermion gas in statistical mechanics are discussed. (C.E.S.)

14934 STOCHASTIC VIEWPOINTS IN IRREVERSIBLE PROCESSES. Ryogo Kubo (Univ. of Chicago). p.179-98 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

The development of the various methods of treating many-body systems and the statistical theory of irreversible processes is summarized. Formalism is presented for the problem of the randomly modulated oscillator. The formalism can be generalized for a wide variety of similar problems in quantum and statistical mechanics. (C.E.S.)

14935 PROGRESS AND PROBLEMS IN S-MATRIX THEORY. Henry P. Stapp (Univ. of California, Berkeley). p.199-216 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

The axiomatics of S-matrix theory is discussed. An acceptable set of axioms is formulated, and a standard of acceptability for the axioms is outlined. Quantum theory postulates, particle-observable postulates, and macroscopic relativistic invariance are considered. (C.E.S.)

14936 CONTRASTS AND CONFLICTS OF S-MATRIX AND FIELD THEORY. M. Dresden (State Univ. of Iowa, Iowa City). p.217-61 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

The relations and conflicts between the field theoretic and S-matrix methods for strong interaction phenomena are discussed. It is suggested that field theory is not applicable to the strong interactions. (C.E.S.)

14937 PUGH'S IMPROVEMENT OF THE GUPTA INDEFINITE-METRIC METHOD APPLIED TO PHOTONS AND TO VECTOR MESONS. Fred J. Belinfante (Purdue Univ., Lafayette, Ind.). p.267-78 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

The Gupta indefinite-metric method for maintaining the conventional relation between the sign of the frequency in the time dependence of the field and the interpretation of the field as a destruction or as an emission operator is briefly described. Improvements to this method, which were introduced by Pugh, that considerably simplify the kinematics of free photons and vector mesons are discussed. (C.E.S.)

14938 RIGOROUS RESULTS IN EQUILIBRIUM STATISTICAL MECHANICS. David Ruelle (Inst. for Advanced Study, Princeton, N. J.). Pt. I, p.1-10 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N. C., University of North Carolina, 1963.

The problem of taking the limit of an infinite system, the so-called thermodynamical limit, in equilibrium statistical mechanics is discussed. The thermodynamic properties of a system containing a very large number of particles that have given microscopic interactions are considered. A classical system of particles interacting via a two-body potential is examined. (C.E.S.)

14939 INELASTIC EFFECTS IN PION-NUCLEON REACTIONS. H. Goldberg and E. L. Lomon (Massachusetts Inst. of Tech., Cambridge). Pt. II, p.75-6 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N. C., University of North Carolina, 1963.

It was shown previously that complicated structure in the $T = \frac{1}{2}$, $S_{\frac{1}{2}}$ state and the resonant $T = \frac{1}{2}$, $D_{\frac{3}{2}}$ state of pion-nucleon scattering can be understood in terms of coupling to other channels. By means of the boundary condition model of strong interactions the $T = 0$ dipion-nucleon channel was coupled to the S state and the ρ meson-nucleon channel to the D state. The results are in excellent agreement with data from 0 to 700 Mev as shown in accompanying graphs. (C.E.S.)

14940 UNITARY SYMMETRY VIA ELECTRODYNAMICS. Behram Kursunoglu (Univ. of Miami, Coral Gables, Fla.). Pt. II, p.80-92 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N. C., University of North Carolina, 1963.

The Lie algebra for the unitary symmetry of strong interactions is derived from the unitary elements of the electrodynamics where Maxwell's energy–momentum tensor can be expressed as $T_{\mu\nu} = \frac{1}{2} < \chi|B_{\mu\nu}|\chi >$, $\mu\nu = 1,2,3,4$. In this expression the ten 3×3 matrices belong to the Lie algebra of U(3) and $|\chi >$ is column vector corresponding to $\epsilon + i\mathfrak{C}$. For the representation of S U(3) the vector $|\chi >$ is replaced by the vector $|a >$ whose components are proton, neutron, and Λ operators. (auth)

14941 A PERTURBATION THEORY WITHOUT THE ADIABATIC HYPOTHESIS. Hiroshi Ezawa (Tokyo Univ. and Univ. of Maryland, College Park). Pt. II, p.93-103 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N. C., University of North Carolina, 1963.

A time-dependent perturbation method that can handle the asymptotic behavior of the scattering process without any use of the adiabatic switching is proposed. (auth)

14942 STUDIES OF ELASTIC AND INELASTIC ELECTRON SCATTERING BY THIN FOILS. H Miessner. Thesis, Berlin, Technische Universitllt, 1963. 57p. $2.00 (Gmelin, AED-DISS. 63-104). (In German)

An apparatus for the measurement of energy and angular distributions in electron diffraction diagrams is described. Electrons passing a double capacitor and a reverse potential energy analyzer are measured with a scintillator and a photomultiplier. Minimal current in this apparatus is limited only by the beam noise. 10^{-17} Å can be detected with a time constant of 1 sec. Energy analysis in Debye-Scherrer diagrams indicates that even very thin layers produce appreciable fractions of inelastically scattered electrons. Results of measurements of elastic ring intensities are in agreement an approximative dynamic theory. The angular dependence of the 14.7 ev. energy loss of electrons in Al can be explained by plasma theory. (Gmelin Inst.)

14943 PROCEEDINGS OF THE ATHENS TOPICAL CONFERENCE ON RECENTLY DISCOVERED RESONANT PARTICLES. Basharat A. Munir and Lawrence J. Gallaher, eds. Athens, Ohio, Ohio University, 1963. 316p.

The present knowledge of the various resonance states, including their production, properties, and decays, are discussed. Separate abstracts are prepared for 19 of the

27 papers presented. The remaining papers were previously abstracted in NSA. (C.E.S.)

For abstracts of individual papers see: 14944, 14945, 14946, 14947, 14948, 14949, 14950, 14951, 14952, 14953, 14954, 14955, 14956, 14957, 14958, 14959, 14960, 14961, and 14962.

14944 PARTICLES, RESONANCES AND STRONG INTERACTION SYMMETRY. S. L. Glashow (Univ. of California, Berkeley). p.25-41 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

The eightfold way symmetry scheme is discussed with respect to the extent that it correctly describes the strong interactions and the variety of resonant states they produce. Tests of the eightfold way, mass and mass formulas, electromagnetic properties of baryons, two-body decays of resonances, four-body tests of the eightfold way, undiscovered baryon states, baryon resonance decay into other baryon resonances, and possible undiscovered mesons are considered. (C.E.S.)

14945 OBSERVATIONS OF 2π DECAY OF ω PARTICLE. W. J. Flickinger, D. K. Robinson, and E. O. Salant (Brookhaven National Lab., Upton, N. Y.). p.42-50 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

To investigate the 2π-decay of the meson (ω) a hydrogen bubble chamber was exposed to a 1.7-Bev/c beam of mesons (π^-). The effective mass distribution of the 2 mesons (π) were plotted and the branching ratio of 2π to 3π decay of the meson (ω) was calculated to be $\gtrsim 5\%$. (C.E.S.)

14946 STRANGE-PARTICLE RESONANCES IN π^-p AND K^-p INTERACTIONS. Gerald A. Smith (Univ. of California, Berkeley). p.67-79 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

A hydrogen bubble chamber exposed to beams of mesons (π^-) at 1.5 to 2.4 Bev/c and mesons (K^-) at 1.0 to 1.7 Bev/c was used to investigate strange-particle resonances in π^-p and K^-p interactions. The mass distribution curves and cross sections are presented. (C.E.S.)

14947 Y* PRODUCTION IN $\bar{p}$-p COLLISIONS. A. M. Thorndike (Brookhaven National Lab., Upton, N. Y.). p.105-13 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

A hydrogen bubble chamber exposed to a beam of antiprotons at 3.25 and 3.69 Bev/c was used to investigate the production of the $\bar{Y}_1^*$. The $\bar{Y}_1^*$ events were compared with $\bar{\Lambda}^0$ and $\bar{N}_{\frac{3}{2}}^*$ events. (C.E.S.)

14948 RESONANCES AS OBSERVED IN K_2^0-p COLLISIONS. F. Eisler, T. C. Bacon, and H. W. K. Hopkins (Brookhaven National Lab., Upton, N. Y.). p.114-120 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

Resonances produced in $K_2^0 + p \rightarrow \pi^+ + \pi^+ + \pi^- + \Lambda$ and $K_2^0 + p \rightarrow p + \pi^+ + \pi^- + K_1^0$ are investigated at incident momenta of ~2 Bev/c. The production of N^*, K^*, $Y_{\frac{3}{2}}^*$, and Y_1^* is discussed. (C.E.S.)

14949 PRELIMINARY STUDY OF RESONANCE PRODUCTION IN THE $\Xi K\pi$ FINAL STATE. P. L. Connolly (Brookhaven National Lab., Upton, N. Y.), E. L. Hart, K. W. Lai, et al. p.121-9 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

The K^- + p interactions at 2.3 Bev/c that lead to the final states $\Xi^- + \pi^+ + K^0$, $\Xi^- + K^+ + \pi^0$, and $\Xi^0 + K^+ + \pi^-$ were investigated. Evidence for structure in the $\Xi\pi$ and $K\pi$ mass distributions and the interpretation of this structure are discussed. (C.E.S.)

14950 K* PRODUCTION IN K-p INTERACTIONS AT 2.26 Bev/c. R. Kraemer, L. Madansky, I. Miller, A. Pevsner, C. Richardson, R. Singh, and R. Zdanis (Johns Hopkins Univ., Baltimore). p.130-4 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

The $K^+ + p \rightarrow K^+ + \pi^- + p + \pi^+$ interaction that proceeds primarily through the two-body final state $K^* + N^*$ was investigated at 2.26 Bev/c. The K* production angular distribution is strongly peaked in the forward direction, suggesting that the reaction takes place through a dominant one pion exchange mechanism. The spin of the K* was also investigated. (C.E.S.)

14951 ON THE φ MESON. P. L. Connolly (Brookhaven National Lab., Upton, N. Y.), E. L. Hart, K. W. Lai, et al. p.135-51 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

The resonance in the $K\bar{K}$ system, called the meson (φ), produced in the interactions $K^- + p \rightarrow \Lambda + K^0 + K^0$ and $K^- + p \rightarrow \Lambda + K^+ + K^-$ at 2.23 Bev/c, was investigated. The mass, width, parity, spin, and isospin of the meson (φ) were determined. The branching ratio for the 2π and $\pi + \rho$ decay modes of the meson (φ) was also measured. (C.E.S.)

14952 METHODS OF DETERMINING THE QUANTUM NUMBERS OF EXCITED MESON AND BARYON STATES. D. B. Lichtenberg (Stanford Univ., Calif.). p.152-61 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

Experimental methods for determining the quantum numbers of excited meson and baryon states are discussed. The applicability of Bose, Fermi, and parastatistics is considered. Previously proposed analytical methods are also discussed. (C.E.S.)

14953 THE SPIN PARITY OF THE $\Xi_{\frac{1}{2}}^*$ (1530) RESONANCE. P. E. Schlein, G. M. Pjerrou, D. Carmony, W. E. Slater, D. H. Stork, and H. K. Ticho (Univ. of California, Los Angeles). p.162-72 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

An attempt to determine the spin parity of the $\Xi_{\frac{1}{2}}^*$ resonance, which was produced in the interaction $K^- + p \rightarrow \Xi^{*0} + K^0$ and $K^- + p \rightarrow \Xi^{*-} + K^+$ at 1.80 and 1.95 Bev/c, is described. (C.E.S.)

14954 PION RESONANCES AND NUCLEON-NUCLEON SCATTERING BELOW 400 Mev. A. Scotti and D. Y. Wong (Univ. of California, La Jolla). p.173-84 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

The effects of the multi-pion resonances η, ρ, ω, and φ on nucleon interactions are considered. Relativistic dispersion relations that include the exchange of these resonances are used to calculate elastic N-N scattering amplitudes, differential cross sections, polarization, and depolarization in the energy range from zero to 400 Mev. In addition to the single pion exchange and the exchange of the resonances, the exchange of an S-wave π-π pair in the

form of an effective scalar particle is also included. (C.E.S.)

14955 η^0 AND ω^0 PRODUCTION IN π-N COLLISIONS. T. Fields (Northwestern Univ., Evanston, Ill. and Argonne National Lab., Ill.), S. Orenstein, B, Kraemer, L. Madansky, M. Meer, A. Pevsner, C. Richardson, and T. Toohig. p.185-92 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

The reaction $\pi^+ + d \rightarrow p + p + (\eta^0 \text{ or } \omega^0)$ was investigated at 1230 Mev/c. The experiment basically reduces to the $\pi^+ + n$ reaction. The effective mass distributions and cross sections are presented. (C.E.S.)

14956 UNITARY SYMMETRY AND DECAYS OF φ AND η MESONS. S. Okubo (Univ. of Rochester, N. Y.). p.193-6 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

The decays of the mesons (φ) and (η) were investigated in connection with the unitary symmetry model. The decays $\varphi \rightarrow K + \overline{K}$, $\varphi \rightarrow 3\pi$, $\varphi \rightarrow \rho + \pi$, $\varphi \rightarrow 2\pi$, $\eta \rightarrow 2\gamma$, $\eta \rightarrow 3\pi$, $\eta \rightarrow 2\pi + \gamma$, and $\eta \rightarrow 2\gamma + \pi$ are considered. (C.E.S.)

14957 A METHOD FOR MEASUREMENT OF COUPLING CONSTANTS. Marc Ross (Indiana Univ., Bloomington). p.219-25 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

A method is proposed for measuring coupling constants or partial widths of resonances that are small or normally inaccessible for kinematical reasons. The idea is described in terms of observing breakup of a compound particle into a particular set of its constituent particles. One can observe the tail of a partial width to a channel that is normally inaccessible by observing the breakup, at higher energy, of the virtually produced particle. Applications of the method are discussed. (C.E.S.)

14958 NUCLEI, HYPERNUCLEI, AND THE EIGHTFOLD WAY. Robert J. Oakes (Stanford Univ., Calif.). p.226-35 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

The eightfold way symmetry scheme is discussed with respect to many-baryon states such as nuclei and hypernuclei. A classification of all the states consisting of up to five baryons is given. The baryons n, p, Σ^-, Σ^0, Σ^+, Λ, Ξ^-, and Ξ^0 and the many-baryon states H^2, H^3, He^3, ΛH^3, He^4, ΛHe^4, and ΛH^4 are assigned to unitary multiplets. (C.E.S.)

14959 RESONANCE-LIKE EFFECTS IN PION-NUCLEON INTERACTIONS BELOW 1 Bev. V. P. Kenney and C. N. Vittitoe (Univ. of Kentucky, Lexington). p.246-58 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

Resonance-like effects that occur in pion-nucleon interactions from the pion production threshold up to the region where ρ-production is expected to dominate are discussed. Peaking in the total cross section, the pion-nucleon 3,3 state considered as a quasi-bound state or isobar, the nonresonant π-π interaction, and two-pion states are considered. (C.E.S.)

14960 η-MESON PRODUCTION BY γ RAY AND THE SECOND RESONANT STATE OF NUCLEON. Shigeo Minami (Louisiana State Univ., Baton Rouge). p.280-7 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

The $\gamma + p \rightarrow \eta + p$ reaction is studied from a field theory viewpoint by taking into account both the process $\gamma + p \rightarrow N^{**} \rightarrow \eta + p$ and the process corresponding to perturbation where the N^{**} is described approximately in terms of a Rarita-Schwinger particle with spin $3/2$. The reaction is studied in the incident photon energy region 740 to 830 Mev where only the second resonant state N^{**} has a large effect and the effect of the third resonant state N^{**} ($I = 1/2$, $M = 1688$ Mev) is negligible. (C.E.S.)

14961 EFFECTS OF THE f^0 MESON ON PION-NUCLEON SCATTERING AT ABOUT 2 Bev. Shigeo Minami (Louisiana State Univ., Baton Rouge). p.288-93 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

Maxima in the cross sections of π^--p and π^+-p interactions at 2 and 2.35 Bev, respectively, are discussed. These maxima are described in terms of the effects of the f^0 meson. The kind of state in the π-N system, i.e., total angular momentum and parity, that is responsible for the maximum in the π^--p cross section is discussed. (C.E.S.)

14962 PRODUCTION OF NUCLEON ISOBARS AND MULTIPION RESONANCES BY 3.5 Bev/c π^+ IN HYDROGEN. Richard L. Lander, Werner Mehlhop, Nguyen-huu Xuong, and P. M. Yager (Univ. of California, La Jolla). p.294-306 of "Proceedings of the Athens Topical Conference on Recently Discovered Resonant Particles." Athens, Ohio, Ohio University, 1963.

An analysis of $\pi^+ + p \rightarrow \pi^+ + p + \pi^+ + \pi^-$ and $\pi^+ + p \rightarrow \pi^+ + p + \pi^+ + \pi^- + \pi^0$ at 3.5 Bev/c is presented. The production of N^*, ρ, and f^0 is discussed. (C.E.S.)

14963 COMPREHENSIVE MASS SCHEME. B. Durrant (Cambridge Univ., Eng.). 22p. (CONF-417-11)

From American Physical Society Meeting, Pasadena, Calif., Dec. 1963.

It is shown that the masses, relative to the proton mass, of all particles, resonances, and hyperfragments may be closely approximated using a simple collective model in which all ground states with vibration quantum number $N = 1$ may be expressed in terms of a new quantum number $\Lambda = 0$ or $1/2$, associated with the rotation of the nucleus. The model expresses mass in terms of an energy scale that is independent of the size of the nucleus, but that is related to the Compton wavelength of the equivalent particle. 65 references. (R.E.U.)

Field Theory and Quantum Mechanics

14964 (AFCRL-63-169) FUNDAMENTAL RESEARCH ON ELECTROMAGNETIC THEORY AND MICROWAVE SPECTROSCOPY. R. Pratesi, L. Ronchi, A. M. Scheggi, and G. Toraldo di Francia (Italy. Consiglio Nazionale delle Ricerche. Centro di Studio per la Fisica delle Microonde, Florence). Mar. 1963. 20p. (AD-413327)

Some theoretical investigations of the production of electromagnetic radiation, particularly of millimeter and submillimeter wavelengths, by passage of charged particles through various media (conducting screens, dielectric slabs, and films) are summarized. 53 references. (D.C.W.)

14965 (JINR-E-1500) FUNCTIONAL SOLUTION SCHEME FOR RELATIVISTIC STRONG-COUPLING THE-

ORY. [PART] I. G. Heber and H. J. Kaiser (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 16p.

The vacuum expectation value of the S-matrix is represented, following Hori, as a functional integral and separated according to $S_{vac} = \exp(-iW) \int D\phi \exp(-i \int dx L_w)$. Now, the functional integral involves only the part L_w of the lagrangian without derivatives and can be easily calculated in lattice space. A graphical scheme is proposed that formalizes the action of the operator $W = \int dx\, dy\, \delta(x-y)(\delta/\delta\rho(y))\,\Box_x\,(\delta/\delta\rho(x))$. The scheme is worked out in some detail for the calculation of the two-point-function of neutral Bose fields with the self-interaction $\lambda\phi^M$ for even M. A method is proposed that under certain convergence assumptions should yield in a finite number of steps the lowest mass eigenvalues and the related matrix elements. The method exhibits characteristic differences between renormalizable and nonrenormalizable theories. (auth)

14966 (JINR-P-1453) O POVEDENII FUNKUII GRINA V TEORII POLYA NA MALYKH RASSTOYANIYAKH. (On Behavior of Green Functions at Small Distances in Field Theory). G. Domokosh and P. Shuranyi (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 9p.

The asymptotic behavior of the four-time Green function at small distances is investigated. This behavior depends critically on the renormalization of field theory. For the non-renormalizable interactions the Bethe-Salpeter equation yields a well-defined solution, but with an essential singularity at the coordinate origin. Physical applications are discussed. (auth)

14967 (LADC-5744) ON THE RELATION OF MICROCAUSALITY TO GAUGE INVARIANCE IN QUANTUM ELECTRODYNAMICS. J. M. Canfield (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract [W-7405-eng-36]. 7p.

It is shown that microcausality of the electron field current density operator is sufficient to insure gauge invariance of the second kind for quantum electrodynamics. A slightly generalized condition of gauge invariance is given and applied to stochastic quantum electrodynamics, which is found to be not strictly gauge invariant. The additional terms in the stochastic s-matrix arising from gauge transformation are examined briefly. (auth)

14968 (TID-20300) SEPARATION OF SETS OF VARIABLES IN QUANTUM MECHANICS. R. A. Marcus (Brookhaven National Lab., Upton, N. Y. and Brooklyn. Polytechnic Inst.). [nd]. Contract [AT(30-1)-1715]. 27p.

Separation of the Schroedinger equation for molecular dynamics into sets of variables can sometimes be performed when separation into individual variables is neither possible nor, for certain purposes, necessary. Sufficient conditions for such a separation are derived. They are the same as those found by Stäckel for the corresponding Hamilton-Jacobi problem, with an additional one which is the analog of the Robertson condition for one-dimensional sets. Expressions are also derived for operators, the eigenvalues of which are the separation constants. They provide a variational property for these constants. For use aperiodic problems, an expression is obtained for the probability current in curvilinear coordinates in an invariant form. (auth)

14969 ELECTROMAGNETIC WAVES IN GENERAL RELATIVITY AS THE SOURCE OF INFORMATION. Andrzej Białas (Jagellonian Univ., Krakow). Acta Physiol. Polon., 24: 465-9(Oct. 1963).

Trautman's method of obtaining wave-like solutions of the Einstein equations is applied to the case of a spacetime filled with electromagnetic radiation. The solution obtained is a certain type of metric. (auth)

14970 ON LAGRANGIANS WITH HIGH DERIVATIVES. M. Borneas (Polytechnic Inst., Timisoara, Rumania). Acta Physiol. Polon., 24: 471-5(Oct. 1963).

Starting from a Lagrangian with high-order derivatives, a "canonical conjugate momentum" is defined. With this, certain commutation rules are written. The field momentum and the energy satisfying conservation laws are introduced. Finally two examples are given. (auth)

14971 TWO NOTES ON SPECIAL RELATIVITY. Francis W. Sears (Dartmouth Coll., Hanover). Am. J. Phys., 32: 59-60(Jan. 1964).

A geometric representation of relations between changes in mass, energy, and momentum in special relativity and a derivation of the expression for the relativistic mass of a particle are presented. (C.E.S.)

14972 SCALAR GRAVITATION. Marcel Wellner (Indiana Univ., Bloomington) and Guido Sandri. Am. J. Phys., 32: 36-9(Jan. 1964).

Nordström's scalar theory of gravitation is discussed from a modern point of view and compared with some aspects of general relativity. The equations of motion for test masses, the field equations in the presence of matter, and the extent to which the principle of equivalence, Mach's principle, and the expansion of the universe are contained in this model are discussed. The theory implies what amounts to a Riemannian metric and features a positive energy density for the gravitational field. (auth)

14973 TRANSITION PROBABILITIES FOR THE FORCED QUANTUM OSCILLATOR. Leonard M. Scarfone (Univ. of Vermont, Burlington). Am. J. Phys., 32: 158-62 (Feb. 1964).

Transition probabilities for the forced, undamped quantum harmonic oscillator are obtained by expressing S-matrix elements entirely in terms of Heisenberg states and operators. The application of this method to this elementary-field theoretic model provides a simple example of the contraction technique of modern field theory whereby particles are converted into their corresponding currents. This problem was recently analyzed in the interaction picture from a pedagogical point of view and the treatment presented is given in the same spirit. (auth)

14974 REMARKS ON THE THEORY OF MEASUREMENT. M. M. Yanase (Inst. for Advanced Study, Princeton, N. J.). Am. J. Phys., 32: 208-11(Mar. 1964).

A new classification of quantum mechanical quantities according to their measurability is discussed. Exactly measurable quantities that commute with all the conserved quantities, approximately measurable quantities that do not commute with all additive conserved quantities, and nonmeasurable quantities that are conjugate to the absolute invariants are considered. The epistemological implications of the measurement process are discussed and it is pointed out that the quantum mechanical description of this process does not furnish an adequate explanation of the acquisition of knowledge. (auth)

14975 INCOMING WAVES IN FINAL STATES IN MATRIX ELEMENTS FOR SCATTERING PROBLEMS. I. Adawi (Battelle Memorial Inst., Columbus, Ohio). Am. J. Phys., 32: 211-15(Mar. 1964).

The use of modified plane waves with the spherical incoming waves modification as final states in matrix elements used in calculating scattering cross sections is

discussed from the standpoint of two techniques. The first method makes use of general properties of Green's functions for outgoing and incoming waves and their reciprocity relations. The second method is based on expanding Green's function in terms of modified plane waves with either incoming or outgoing spherical wave modification. (auth)

14976 SOME APPLICATIONS OF MANY-TIME GREEN'S FUNCTIONS TO THE MANY-BOSON PROBLEM. A. J. Kromminga (Ames Lab., Ames, Iowa). Ann. Phys. (N. Y.), 26: 307-21(Feb. 20, 1964). (IS-669)

The spectral representation of many-time Green's functions is generalized to Green's functions in which several operators may appear in normal order. The Heisenberg picture matrix elements are given for the Green's function having one external interaction line and one external quasiparticle line, and for the Green's function having two external interaction lines. It is shown how these Green's functions can be used to calculate the chemical potential and the correlation function. (auth)

14977 THE MASS LEVELS AND THE BROKEN SYMMETRY IN TERMS OF INEQUIVALENT REPRESENTATIONS. Hiroomi Umezawa (Tokyo Univ.); Yasushi Takahashi, and Susumu Kamefuchi. Ann. Phys. (N. Y.), 26: 336-63(Feb. 20, 1964).

It is pointed out that inequivalent representations inherent in the theory of quantized fields in an infinite volume play an essential role in deriving mass levels and broken symmetries. A set of continuous parameters is introduced to specify these representations. From the requirement that the Hamiltonian shall tend to that of asymptotic fields as the volume becomes infinite, suitable representations are singled out. This requirement further determines possible values of the mass, which exhibit, in general, broken symmetries. It is also shown that with this method Nambu's "Superconductor theory" of elementary particles can be formulated in a consistent manner. (auth)

14978 QUANTUM MECHANICS AND PROBABILITY THEORY. CRITICISM OF FEYNMAN'S POSITION. H. Breny (Universite, Liege). Ann. Soc. Sci. Bruxelles, Ser. I, 77: 99-106(Dec. 20, 1963). (In French)

Feynman's contention that quantum mechanics and the classical theory of probability are incompatible is refuted by a re-examination of his reasoning. (D.C.W.)

14979 TABLES OF ANGULAR MOMENTUM TRANSFORMATION MATRIX ELEMENTS $d^{(j)}_{m',m}(\beta)$ (j = 2, 4, 6). H. A. Buckmaster (Univ. of Alberta, Calgary, Can.) Can. J. Phys., 42: 386-91(Feb. 1964).

Crystalline electric field angular momentum operator equivalent transforms are given. (R.E.U.)

14980 THE RADIAL EQUATIONS OF A PARTICLE OF ANY SPIN IN INTERACTION WITH A CENTRAL POTENTIAL. Andre Jolivet (Institut Henri Poincaré, Paris). Compt. Rend., 258: 1419-22(Feb. 3, 1964). (In French)

A simple expression is given for the irreducible forms of the matrix system used to describe a particle with any spin. The radial equations for a particle with any spin were determined for the case of an interaction in spherical symmetry. (tr-auth)

14981 FORM OF INTERACTION BETWEEN SYSTEMS OF ARBITRARY ANGULAR MOMENTA. M. Jameel (Atomic Energy Centre, Lahore). J. Nat. Sci. and Math., 3: 99-105(Oct. 1963).

The permissible form of the potential between two systems of arbitrary spin is derived, subject only to certain reasonable physical requirements. (auth)

14982 ON THE NONLINEAR SPINOR THEORY. K. Ladányi (Max-Planck-Institut für Physik und Astrophysik, Munich). Nuovo Cimento (10), 31: 809-26(Feb. 16, 1964).

The relativistic Fock methods are adopted for the nonlinear spinor theory. Some remarks about the quantization and the properties of the simplest amplitudes are discussed. A relatively simple approximation of the two-point Fock equation is developed. The Fock equation of the propagator function is considered using the approximations developed. A self-consistent method is suggested to calculate masses and coupling constants. (auth)

14983 A SOLUBLE TWO-DIMENSIONAL FIELD THEORY SATISFYING UNITARITY AND CROSSING SYMMETRY. D. W. Schlitt (Univ. of Maryland, College Park). Nuovo Cimento (10), 31: 858-73(Feb. 16, 1964).

A theory describing spinless, neutral bosons in a universe with one space dimension is investigated. It is assumed that the scattering amplitudes are analytic functions of the momenta of the particles with only those singularities required by unitarity and crossing symmetry. The general solution for the elastic scattering amplitude is obtained under the assumption that all inelastic amplitudes vanish. In spite of the absence of inelastic processes, the solution is entirely consistent with analyticity, unitarity, and crossing symmetry. The class of solutions which approach a constant at high energy is investigated in detail; it is found that these solutions are in agreement with conventional perturbation theory with a $\lambda\phi^4$ interaction through terms of order λ^3. The effects of crossing symmetry and inelastic processes are investigated. It is found that the low-energy scattering is insensitive to crossing symmetry and the presence of inelastic effects. The behavior of resonances and bound states as a function of the coupling constant does depend strongly on crossing symmetry and the inelastic term in the unitarity condition. (auth)

14984 UNITARY SYMMETRY AND THE WEAK CURRENTS. [PART] II. D. Horn and Y. Ne'eman (Tel-Aviv Univ., Israel and Israel Atomic Energy Commission, Yavne). Nuovo Cimento (10), 31: 879-83(Feb. 16, 1964).

The weak currents that appear in the leptonic decay modes of the hadrons are classified on the basis of unitary symmetry representations. The development of the theory rests on the notion of conserved vector currents that are implied by the symmetry. The fit with the experimental situation is discussed. (auth)

14985 ON THE CONNECTION BETWEEN S-MATRIX AND THE NEUMANN SERIES EXPANSION OF THE WAVE FUNCTION. L. Favella (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 31: 890-903(Feb. 16, 1964).

It is proved that the S-matrix may be expressed as the quotient of two series involving the coefficients a_n of the Neumann series expansion of the wave function $\varphi_\nu(x)$. This expansion is equivalent to writing the same wave function as a Lebedev-Kontorovich transform, which provides through the differential equation a system of linear algebraic equations in triangular form for the coefficients a_n. (auth)

14986 THE WIGNER DISTRIBUTION FUNCTION IN QUANTUM STATISTICS AND THE APPLICATION TO SECOND VIRIAL COEFFICIENTS. R. Haberlandt (Deutschen Akademie der Wissenschaften, Berlin). Phys. Letters, 8: 172-5(Feb. 1, 1964).

The Wigner distribution function is given for one dimension. The third quantum correction to the second virial coefficient is calculated. (R.E.U.)

14987 IMCOMPATIBILITY OF THE EXACT AND APPROXIMATE BOOTSTRAP CONDITIONS IN A SOLUBLE MODEL. B. Diu and H. R. Rubinstein (Faculte des Sciences, Saclay, France). Phys. Letters, 8: 203-5(Feb. 1, 1964).

A model is discussed in which "exact" solutions can be obtained without considering one-particle exchange graphs to calculate left-hand discontinuities. These "exact" solutions are compared with the usual "approximate" solutions. (R.E.U.)

14988 ON THE CORRELATION BETWEEN THE EXACT SOLUTION AND THE PERTURBATION THEORY SERIES IN THE CASE OF SCHROEDINGER EQUATION WITH SINGULAR POTENTIAL. B. A. Arbuzov, A. T. Filippov, and O. A. Khrustalev (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 8: 205-7(Feb. 1, 1964).

The effective potentials in nonrelativistic quantum field theory were investigated from exact and perturbative series solutions of the singular-potential Schroedinger equation. (R.E.U.)

14989 ANGULAR MOMENTUM CONTINUATION IN THE THREE-BODY PROBLEM WITHOUT CUTS. R. G. Newton (Indiana Univ., Bloomington). Phys. Letters, 8: 210-11(Feb. 1, 1964).

A way of interpolating the three-body S-matrix in nonrelativistic Schroedinger theory from its physical values that is free of dynamical branch points is discussed. (R.E.U.)

14990 UNIVERSAL WEAK INTERACTION LAGRANGIAN. A. Salam (Imperial Coll. of Science and Tech., London). Phys. Letters, 8: 216-17(Feb. 1, 1964).

Difficulties encountered by the hypothesis of a universal weak interaction Lagrangian for both leptonic and nonleptonic processes are discussed. (R.E.U.)

14991 ANOMALOUS BEHAVIOR OF THE COULOMB T MATRIX. William F. Ford (Lewis Research Center, Cleveland). Phys. Rev., 133: B1616-21(Mar. 23, 1964).

Some apparent discrepancies in the definition or calculation of the Coulomb T matrix are investigated in an approach that uses shielded wave functions. It is found that the screened Coulomb T matrix behaves anomalously in the neighborhood of the energy shell and is in fact discontinuous in the limit of zero screening. A closed-form expression for the T matrix, which has been derived previously, is shown to be essentially correct off the energy shell. (auth)

14992 QUANTUM MECHANICS AND THE RELATIVISTIC HAMILTON-JACOBI EQUATION. Lloyd Motz (Columbia Univ., New York) and Adolph Selzer. Phys. Rev., 133: B1622-4(Mar. 23, 1964).

It is shown that the Klein-Gordon quantum-mechanical operator, operating on the function $e^{iS/\hbar}$, where S is the relativistic action of a free particle or of a particle in a field defined by a four-vector, is completely equivalent to the relativistic Hamilton-Jacobi equation, provided one takes into account the vanishing of the divergence of the energy-momentum four-vector. From this it is seen that classical relativistic mechanics can be formulated in terms of operators that are identical with those used in quantum mechanics. (auth)

14993 QUANTUM INTERFERENCE FROM A STATIC VECTOR POTENTIAL IN A FIELD-FREE REGION. R. C. Jaklevic, J. J. Lambe, A. H. Silver, and J. E. Mercereau (Ford Motor Co., Dearborn, Mich.). Phys. Rev. Letters, 12: 274-5(Mar. 16, 1964).

The maximum supercurrent flowing through two Josephson junctions connected in parallel by superconducting links was measured, and the modulation of the current was found to be periodic with a period very nearly the flux quantum (h/2e) and identical with the period produced by a uniform magnetic field. The flux was produced by a closely wound solenoid arranged to have no net axial current flow. The experiment demonstrates the effect produced by a static vector potential with negligible magnetic field effects. (R.E.U.)

14994 THE GENERALIZATION OF THE BORN-INFELD ELECTRODYNAMICS. C. Gilbert (Univ. of Newcastle-upon-Tyne, Eng.). Proc. Phys. Soc. (London), 83: 181-8(Feb. 1964).

A unified theory of gravitation and electromagnetism is derived from a variational principle. The characteristic action function is an invariant density formed from the Ricci tensor of a semi-symmetric connection. The field equations have the same general character as those of the Born-Infeld electrodynamics and its generalization by Hoffmann and Infeld. The theory presupposes the existence of a fundamental length of the order of magnitude of the electron radius. The Einstein-Maxwell equations are obtained from a special choice of the action function. (auth)

14995 CYLINDRICALLY SYMMETRIC RADIAL ELECTROSTATIC FIELDS IN GENERAL RELATIVITY. M. M. Som (City Coll., Calcutta). Proc. Phys. Soc. (London), 83: 328-30(Feb. 1964).

The non-existence of any physically acceptable solution of the Einstein-Maxwell equations that can be identified as that of a charged infinite cylinder with a radial electrostatic field is established. (auth)

14996 A SOLUBLE MODEL OF THE PARTIAL WAVE DISPERSION EQUATION AND THE BOOTSTRAP APPROXIMATION. Akira Kanazawa, Naoki Tokuda, and Yasuyuki Kurata (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 30: 879-86(Dec. 1963).

An exactly soluble model of a p-wave dispersion equation is investigated to see the validity of the bootstrap approximation. The model contains a parameter which is related to the coupling constant of the corresponding field theoretical model, the meson pair theory with a generalized separable interaction potential. For a certain range of the parameter, the model exhibits a resonance of positive width and the bootstrap equation can be constructed for the resonance. Its equation can be solved numerically, which gives the position and the reduced width of the resonance as the functions of the parameter. The results are compared with the exact one and the validity of the bootstrap approximation is discussed in detail. (auth)

14997 CONVERGING SCATTERING THEORY AND ITS APPLICATION. Tatuya Sasakawa (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 30: 913-14(Dec. 1963).

A method is described for potential scattering in which the asymptotic wave inside the scatterer is taken as a zero-order function in the iteration procedure. The scattering amplitude is determined self-consistently. (R.E.U.)

14998 ON STRONG INTERACTION SYMMETRIES BASED ON SIMPLE LIE GROUPS. Mineo Ikeda (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 30: 915-16(Dec. 1963).

Mathematical restrictions to a theoretical framework of supermultiplets and isomultiplets, and the identification of the multiplet members, are discussed for strong interaction symmetries based on Lie groups. (R.E.U.)

14999 PARAMETRIC INTEGRAL FORMULAS AND ANALYTIC PROPERTIES IN PERTURBATION THEORY. Noboru Nakanishi (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), Suppl., No. 18, 1-81(1961).

The general term in perturbation theory is explicitly given in terms of the Feynman parametric integral. The properties of the parametric functions appearing in this integral are investigated in detail. By using this formula, systematic investigations on the singularities of the general term are extensively developed. Dispersion relations for various forward and non-forward scatterings (and vertex functions) and other integral representations for the vertex function are proved in every order of perturbation theory. (auth)

15000 WIGHTMAN FUNCTIONS, RETARDED FUNCTIONS AND THEIR ANALYTIC CONTINUATIONS. Huzihiro Araki (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), Suppl., No. 18, 83-125(1961).

Recent studies on the analyticity of the general n-point Wightman functions and the retarded functions in quantum field theory are reviewed. According to Wightman, the conventional axiom of quantum field theory is transcribed into an equivalent set of properties of the Wightman functions. It is then shown that the Wightman functions are boundary values of analytic functions in complex coordinate spaces and the linear properties of the Wightman functions are transcribed into an equivalent requirement on domains of analyticity of these analytic functions. For the study of retarded functions, the contributions of vacuum intermediate states are systematically subtracted from the Wightman functions. The truncated Wightman functions thus obtained have the same linear properties as those of the Wightman functions except for a smaller support in the momentum space. A generalization of θ-function (the step function of Heaviside) to the characteristic function of a convex polyhedral cone in an n-dimensional vector space is defined and is used to define the generalized retarded functions. The properties of the latter that are equivalent to the linear properties of the Wightman functions are stated. It is then shown that the generalized retarded functions are boundary values of analytic functions in complex momentum spaces, and a part of the properties of the former are transcribed into an equivalent requirement on domains of analyticity of the latter. The whole discussion is carried out regardless of the choice between local commutativity and anticommutativity. The problem of obtaining the envelope of holomorphic remains unsolved. (auth)

15001 THE PAULI-FIERZ TRANSFORMATION GROUP AND FOUR-BOSON INTERACTION LAGRANGIANS (FIVE-ROW REPRESENTATION). V. Loorits and H. Õiglane. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 22, 61-5 (1963). (In Russian)

A formalism in which interaction lagrangians are treated as eigenvectors of the operators of the Pauli-Fierz group is applied to the cases of four-boson interaction. The representation by five-row matrices was subjected to a detailed analysis. (auth)

15002 ON THE RELATION BETWEEN MASS AND CHARGE OF A SPHERICAL BODY. A. Koppel. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 22, 74-7(1963). (In Russian)

The motion of a charged spherical body in a gravitational field is considered. The contribution of the electrostatic field of the particle to the gravitational mass of the particle is discussed. (C.E.S.)

15003 THE BEHAVIOUR OF THE FIRST-ORDER DENSITY MATRIX AT THE COULOMB SINGULARITIES OF THE SCHRÖDINGER EQUATION. Werner A. Bingel (Univ. of Florida, Gainesville). Z. Naturforsch., 18a: 1249-53(Dec. 1963).

The cusp conditions of Kato for a spinless n-electron wave function at the Coulomb singularities of the Schrödinger equation were used to derive corresponding conditions for the first-order density matrix. These results were applied to the united-atom expansion of the electronic energy of polyatomic molecules resulting in an exact relation between the coefficients of the quadratic and cubic terms in this expansion. It is shown how the cusp condition for the first-order density matrix is modified if the wave function includes electron spin in a proper way. (auth)

15004 OBSERVATION AND COARSE-GRAINED DESCRIPTION IN QUANTUM THEORY. W. H. Furry (Harvard Univ., Boston). Pt. II, p.19-29 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N. C., University of North Carolina, 1963.

A discussion of measurements in quantum theory that involves both the physical properties of material systems and the role of observation in obtaining knowledge about such systems is presented. The effects of the measuring apparatus on the object system are considered. (C.E.S.)

15005 EQUIVALENCE OF STATES. A. Lewis Licht (Naval Ordnance Lab., Silver Spring, Md. and Univ. of Maryland, College Park). Pt. II, p.30-40 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N. C., University of North Carolina, 1963.

A notion of equivalence of states with respect to measurements in space-time regions is defined. Some of the properties of this equivalence relation are investigated. It is shown that there is a close connection between the algebraic structure of the rings of operators generated by the observables and the limitations imposed on the measurement process by a certain axiom of primitive locality. (auth)

15006 TOEPLITZ DETERMINANTS AND COULOMB GASES. Freeman J. Dyson (Inst. for Advanced Study, Princeton, N. J.). Pt. I, p.43-52 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N. C., University of North Carolina, 1963.

The thermodynamic limit as an approximation to the exact behavior of a many-particle system is discussed. A set of unit charges free to move on the circle $|z| = 1$ under the laws of classical mechanics with an external potential $U(z)$ is considered. Thermodynamic approximations, Toeplitz matrices, and Szegö's theorem are examined and used to calculate the one-particle density matrix for a quantum-mechanical Bose gas of N particles on a circle with the potential between two particles being an infinitely strong repulsive delta-function. (C.E.S.)

15007 SUCCESSIVE FINITE APPROXIMATIONS FOR THE FERMION PROPAGATOR. T. A. Welton (Oak Ridge National Lab., Tenn.). Pt. II, p.104-12 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N. C., University of North Carolina, 1963.

The divergence difficulties of quantum field theory are discussed, and a formalism is presented that seems capable of determining a finite value for the experimental mass of a fermion that interacts only with a vacuum boson field in terms of the bare fermion mass, the coupling constant

to the boson field, and the boson mass. The case of a neutral fermion field coupled with pseudoscalar coupling to a neutral pseudoscalar boson field is examined. It is shown that the contributions of all graphs without closed fermion loops can be obtained by an obvious analytic continuation from an analogous set of graphs for the seemingly unrelated mathematical problem of the solution of a particle wave equation in Dirac form in a four-dimensional Euclidean space with a random force acting. (C.E.S.)

15008 THE NATURE OF PERTURBATION EXPANSIONS IN REGULARIZED YUKAWA FIELD THEORIES. William M. Frank and A. Lewis Licht (Naval Ordnance Lab., Silver Spring, Md.). Pt. II, p.113-20 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N. C., University of North Carolina, 1963.

The analytic properties in the coupling constant of transition amplitudes are investigated in field theories where massive bosons and fermions interact via a Yukawa coupling and the bare propagators are regularized. It was found that the physical amplitudes as a function of the complex variable $Z = \frac{1}{2} g^2$ (g = Yukawa coupling constant) is an analytic function in a plane with an infinite number of cuts. A semi-infinite region of the plane was found in which it can be shown that there are no singularities. (C.E.S.)

15009 ELECTROMAGNETIC THEORY. Erik Hallén. Translated by Runar Gåsstroem from the Swedish. New York, John Wiley & Sons, Inc., 1962. 629p. $20.00.

A text is given of various phases of electromagnetic theory, including: electrostatics; direct currents; stationary electromagnetism; electromagnetic induction; steady-state alternating currents; and electromagnetic field theory. (T.F.H.)

15010 VARIATIONAL PRINCIPLES IN THE THEORY OF COLLISIONS. Yu. N. Demkov. Translation by N. Kemmer of "Variyatsionnyye printsipy v teorii Stolknevenii." A Pergamon Press Book. New York, The Macmillan Company, 1963. 165p.

After a generalized formulation of the variational principle, the principle is used in an analysis of concrete problems. Only stationary, nonrelativistic collisions are considered. The variational principle is applied to nonrelativistic quantum mechanics and field theory. The relations between various formulations of the variational principle are discussed. Conditions and symmetry properties that must be obeyed by the scattering amplitudes and cross sections are detailed. Variation of scale is used to derive, from a variational principle, formulas applying to various cases that are analogous to the virial theorem in the case of the discrete spectrum. (T.F.H.)

15011 MODERN QUANTUM THEORY. Behram Kurşunoğlu. A Series of Books in Physics. San Francisco, W. H. Freeman and Company, 1962. 529p. $14.00.

The fundamental mathematic requirements for a study of modern quantum mechanics are outlined. Attention is then turned to topics in quantum mechanics such as: quantum electrodynamics; the general formalism of quantum mechanics; angular momentum; transformation theory; equations of motion; symmetry principles and quantum statistics; harmonic oscillator representations; Lorentz group; symmetries of massless particles; wave equation of particles of spin $\frac{1}{2}$ with mass; quantization of massless fields; probability in classical and quantum physics; energy levels and symmetries of simple systems; approximation methods; interactions with radiation; many-particle systems; elementary scattering theory; and the formal theory of scattering. (T.F.H.)

15012 TEORETICHESKAYA FIZIKA. TOM II. TEORIYA POLYA. (Theoretical Physics. Vol. II. Field Theory). L. D. Landau and E. M. Lifshits. Moscow, Publishing House of Literature on Physics and Mathematics, 1962. 422p.

The theory of electromagnetic and gravitational fields is presented, and problems of microscopic and vacuum electrodynamics are discussed. The book is divided into eleven chapters with the first chapter treating the theory of relativity, the second relativistic mechanics, and the third the charge in electromagnetic field. Constant electromagnetic fields, electromagnetic waves, light propagation, and moving charges are discussed in the sixth, seventh, and eighth chapters, respectively, while electromagnetic radiation, particles in gravitational fields, and gravitational field equations are discussed in the ninth, tenth, and eleventh chapters. (R.V.J.)

15013 HIDDEN SYMMETRY AND QUANTUM ELECTRODYNAMICS. J. D. Bjorken (Stanford Univ., Calif.). p.45-9 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

An attempt is made to describe the photon as a composite particle, that is, a Goldstone boson with the hidden symmetry being Lorentz invariance. (C.E.S.)

15014 BROKEN SYMMETRIES AND MASSLESS PARTICLES. Abraham Klein and Sidney Bludman (Univ. of Pennsylvania, Philadelphia). p.50-64 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

A theorem applicable to a wide class of quantum field theories is discussed. The class of systems discussed is those whose ground states are characterized by one or more long range order parameters. Examples include the ferromagnet, the superconductor, and superfluid He. The theorem guarantees that among the long wavelength excitations of such a system, there is generally at least one branch whose energy vanishes in the limit as the wavelength becomes infinite. (C.E.S.)

15015 WAVE EQUATIONS FOR PARTICLES WITH HIGH SPIN. D. L. Weaver, C. L. Hammer, and R. H. Good, Jr. (Ames Lab., Ames, Iowa). p.279-82 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

Wave equations for noninteracting high spin (greater than $\frac{1}{2}$) particles are constructed. The treatment is such that the plane wave solutions, integrals of motion, and massless limit are easily obtained. (C.E.S.)

15016 BOSE-EINSTEIN CONDENSATION AND THE GRAND CANONICAL ENSEMBLE. Robert Mills (Ohio State Univ., Columbus). p.290-4 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

The problem of using field theory methods for a Bose gas at finite temperatures below the transition temperature for the unperturbed system was discussed. The nonequivalence of the canonical and grand canonical ensembles is shown, and the physical significance of the nonequivalence is considered. (C.E.S.)

Geophysics

15017 (N63-17339) INTERACTION BETWEEN THE SOLAR WIND AND THE GEOMAGNETIC FIELD. James

Hurley (New York Univ., New York. Coll. of Engineering). Mar. 1, 1961. Contract DA-36-039SC-87171. 82p.

There is now considerable evidence for the existence of an interaction between the solar wind and the geomagnetic field. The solar wind is a highly ionized plasma and as such may well influence the geomagnetic field. The investigation was limited to a two dimensional model to permit an exact solution to be obtained. The plasma wind is considered as impinging upon an arbitrarily oriented two-dimensional magnetic dipole. It is found that the field is compressed by the plasma and essentially confined to form a cavity in the plasma wind. The thickness of the boundary layer within which the plasma and field interact is found to be small. The equation of this boundary surface and the extent to which the field is changed by such a confinement were determined. The stability of such a system was considered. It is found that there are certain regions of instability, but for the part of the surface facing the wind it is stable. (auth)

15018 (RM-4031-PR) THE EFFECT OF IONS ON LF AND VLF PROPAGATION IN AN ABNORMALLY IONIZED ATMOSPHERE. C. M. Crain and H. G. Booker (RAND Corp., Santa Monica, Calif.). Mar. 1964. Contract AF 49(638)-700. 12p.

It is shown by an approximate approach that ions, not electrons, dominate the propagation effects of low and very low frequency skywaves through an abnormally lowered D-layer. (D.C.W.)

15019 VARIATIONS IN THE SCINTILLATION OF COSMIC RADIO SOURCES DEPENDENT ON THE SCINTILLATION RATE. G. A. Harrower and R. Srivastava (Queen's Univ., Kingston, Ont.). Can. J. Phys., 42: 251-8(Feb. 1964).

A study of scintillation of the source Cassiopeia A at 52 Mc/s, using apparatus capable of separating the scintillating wave form into various frequency components, reveals differences between faster scintillations and slower scintillations with the division occurring at approximately 25 seconds. The sidereally dependent differences are pronounced; the local solar time dependent differences are small. All scintillation activity during 1962 showed strong correlation with the number of solar flares. (auth)

15020 A COMMENT ON THE PAPERS ENTITLED "A THEORY OF IONOSPHERIC CURRENTS ASSOCIATED WITH AURORAE I AND II" BY J. T. WEAVER AND R. SKINNER. J. S. Kim and H. Y. Kim (Univ. of Idaho, Moscow). Can. J. Phys., 42: 569-73(Mar. 1964).

A previous model and theory of magnetic disturbance produced by auroral currents set up by the atmospheric dynamo action are shown to be inadequate. (R.E.U.)

15021 A COMPARISON OF HIGH-ALTITUDE NUCLEAR EXPLOSION EFFECTS IN THE E LAYER WITH VARIATIONS IN GEOMAGNETIC FIELD STRENGTH. J. R. Davis and J. M. Headrick (Naval Research Lab., Washington, D. C.). J. Geophys. Res., 69: 911-16(Mar. 1, 1964).

A high-frequency ground-backscatter study conducted during the period of the July 9, 1962, high-altitude nuclear explosion over Johnston Island yielded information that indicates that short-period fluctuations in E-layer ionization occurred over the eastern United States within the first few seconds after the detonation. The onset time, periodic structure, and duration of the E-layer ionization disturbance were found to bear a striking similarity to variations in the geomagnetic field measured by observers throughout the western hemisphere. The coincidence of geomagnetic field fluctuations and variations in E-layer ionization density is advanced as evidence that the perturbations were caused by neutron-decay β particles interacting with the magnetic field and the ionosphere. (auth)

15022 ON THE GEOMAGNETIC EFFECT OF THE STARFISH HIGH-ALTITUDE NUCLEAR EXPLOSION. H. Maeda (Kyoto Univ.), A. J. Shirgaokar, M. Yasuhara, and S. Matsushita. J. Geophys. Res., 69: 917-45(Mar. 1, 1964).

A high-altitude nuclear explosion, called Starfish, over Johnston Island on July 9, 1962, produced a distinct geomagnetic effect at stations all over the world. This effect consisted of two major parts: initial rapid oscillations followed by slower changes. The rapid oscillations began within several seconds after the shot, and were caused by the propagation of ELF (extremely-low-frequency electromagnetic waves) and hydromagnetic waves. The slower changes reached a maximum a few minutes after the shot and lasted about half an hour. The worldwide pattern of these slow changes indicates that they were due not to a single effect but to a superposition of different effects. A quantitative estimation is made of these slow changes, taking into consideration ionospheric variations, and the results of these estimations are compared with the observed changes. (auth)

15023 THEORY OF IRREGULAR MAGNETIC MICROPULSATIONS ASSOCIATED WITH A MAGNETIC BAY. Atsuhiro Nishida (Univ. of Chicago). J. Geophys. Res., 69: 947-54(Mar. 1, 1964).

A burst of irregular pulsations (period, approximately 0.2 to 200 sec) in the auroral zone, which appears at the onset of a sharp negative bay accompanied by various phenomena testifying the intrusion of a high-speed electron beam from above, is explained by the hydromagnetic instability. It is shown that the presence of a passing electron beam modifies the character of a hydromagnetic wave in the magnetosphere in such a way that the instability is able to take place. With adequately chosen parameters of the beam and the ambient plasma, the range of the period of growing waves generated in the magnetosphere is estimated, and a close agreement is found with that of a pulsation burst. Irregular pulsations in the lower latitudes, which are observed in coincidence with the pulsation burst in the auroral zone, may be due to the oblique propagation of these growing waves and the leakage of the screening current, which flows in the auroral zone when the pulsation burst is taking place. (auth)

15024 ON THE DETERMINATION OF TEMPERATURE AND IONIC COMPOSITION BY ELECTRON BACKSCATTERING FROM THE IONOSPHERE AND MAGNETOSPHERE. D. R. Moorcroft (Stanford Univ., Calif.). J. Geophys. Res., 69: 955-70(Mar. 1, 1964).

Observations of the scattering of electromagnetic waves from thermal fluctuations in the electron density of the ionosphere and magnetosphere were previously used to investigate ion and electron temperatures and the electron density. This work was based on the assumptions that the only ions present were O^+, and that $kD = 4\pi D/\lambda_T \ll 1$ (λ_T is the transmitted wavelength, and D is the Debye length). These conditions usually apply at F-region heights. The interpretation of such scattering is extended to conditions likely to apply above the F region, where increasing percentages of He^+ and H^+ are expected to occur, and where kD may not be very small. Detailed curves are presented for mixtures of O^+ and He^+. It appears that, with a sufficiently powerful radar operating at a sufficiently low frequency, scatter observations alone can usually be used to

determine the relative concentrations of O^+ and He^+ (and/or H^+), as well as the electron and ion temperatures and the electron density. When information on one or more of these ionospheric properties is available from another source, simpler scatter observations can be used to complete the set. A simple transformation is given that accurately corrects the interpretation for values of kD up to unity. (auth)

15025 GEOMAGNETIC AND SOLAR DATA. J. Virginia Lincoln, ed. (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 69: 1001-3(Mar. 1, 1964).

Data are presented for the principal geomagnetic storm sudden commencements for the period July to September 1963. Maximum activity and ranges of the storms are presented. Solar activity characteristics are given for October 1963. (C.E.S.)

15026 REMARKS ON PAPERS BY J. W. FREEMAN, J. A. VAN ALLEN, AND L. J. CAHILL, 'EXPLORER 12 OBSERVATIONS OF THE MAGNETOSPHERIC BOUNDARY AND THE ASSOCIATED SOLAR PLASMA ON SEPTEMBER 13, 1961,' AND BY L. A. FRANK, J. A. VAN ALLEN, AND E. MACAGNO, 'CHARGED-PARTICLE OBSERVATIONS IN THE EARTH'S OUTER MAGNETOSPHERE.' K. I. Gringauz (Academy of Sciences, Moscow) and REMARKS ON ACCOMPANYING LETTER BY K. I. GRINGAUZ. James A. Van Allen (Univ. of Iowa, Iowa City). J. Geophys. Res., 69: 1007-13(Mar. 1, 1964).

A discussion of the accuracy of conclusions drawn in previous papers on the magnetospheric boundary and charged-particle fluxes is presented. (C.E.S.)

15027 FURTHER OBSERVATIONS OF SYNCHROTRON RADIATION DECAY. G. R. Ochs (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 69: 1014-16 (Mar. 1, 1964).

The intensity decrease of synchrotron radiation created by the Starfish explosion in July 1962 is plotted for the period July 1962 to October 1963. (C.E.S.)

15028 EFFECTS OF THE U. S. HIGH-ALTITUDE NUCLEAR TEST SERIES OF 1962 ON RADIO PROPAGATION. R. L. Trainor and L. J. Derrick. Nature, 201: 694-5(Feb. 15, 1964).

The effects on the signal level of h-f and v-l-f transmissions during the 1962 high-altitude explosion series are reported. (C.E.S.)

15029 NUCLEAR-REACTOR CONTRIBUTION TO THE VAN ALLEN BELT. Donald G. Carpenter (Air Force Academy, Colorado Springs, Colo). Nucl. Sci. Eng., 18: 289-90(Feb. 1964).

The contribution of relativistic electrons to the Van Allen belt from the decay of thermal neutrons that are introduced by SNAP reactors is discussed. (R.E.U.)

15030 EVIDENCE OF HYDROMAGNETIC WAVES IN THE EARTH'S MAGNETOSPHERE AND OF THEIR PROPAGATION TO THE EARTH'S SURFACE. V. L. Patel and L. J. Cahill, Jr. (Univ. of New Hampshire, Durham). Phys. Rev. Letters, 12: 213-15(Mar. 2, 1964).

Evidence of hydromagnetic waves in the magnetosphere is presented from total vector magnetic field measurement by the Explorer XII magnetometer and simultaneous ground magnetic records from College, Alaska. (R.E.U.)

15031 ON THE ASSOCIATION OF OPTICAL AND RADIO OBSERVATIONS OF THE AURORA. M. Gadsden (D.P.L. Auroral Station, Omakau, N. Z.). Planetary Space Sci., 12: 29-35(Jan. 1964).

Observational evidence is reviewed and shown not to be in support of a suggestion that the lack of association may be strongly influenced by absorption. An observational search to identify emission associated with radar-echoing regions is suggested. (auth)

15032 VISCOUS INTERACTION BETWEEN THE SOLAR WIND AND THE EARTH'S MAGNETOSPHERE. W. I. Axford (Cornell Univ., Ithaca, N. Y.). Planetary Space Sci., 12: 45-53(Jan. 1964).

Order of magnitude calculations are used to show that viscous interaction between the solar wind and the magnetosphere can satisfy the energy requirements of a typical magnetic storm. The viscous interaction is considered to be due mainly to turbulence of a compressible nature in the solar wind, and it is shown that this can provide the necessary drag forces, although other mechanisms are not excluded. (auth)

15033 FAST PHOTOELECTRONS AND HELIUM EMISSION IN THE UPPER ATMOSPHERE. V. I. Krassovskii and N. N. Shefov (Inst. of Physics of the Atmosphere, Moscow). Planetary Space Sci., 12: 91-2(Jan. 1964).

The existence of 50-ev electrons in the atmosphere at up to 300 km is reported, and the excitation of helium emission is discussed. (R.E.U.)

15034 THEORETICAL DETERMINATION OF THE BOUNDARY AND DISTORTION OF THE GEOMAGNETIC FIELD IN A STEADY SOLAR WIND. Benjamin R. Briggs and John R. Spreiter (Ames Research Center, Moffett Field, Calif.). 19p. (CONF-402-2; NASA TR R-178)

From American Geophysical Union 43rd Annual Meeting, Washington, D. C., Apr. 1962.

An approximate formulation of the steady-state Chapman-Ferraro problem, given recently by Davis and Beard, is used to calculate the coordinates of the complete boundary of the geomagnetic field. Field lines are then computed in the magnetic meridian plane containing the free-stream direction of the solar wind, taking into account the distorting effects of currents flowing in the boundary. Numerical results are given for the case where the geomagnetic dipole axis is perpendicular to the direction of the solar wind. (auth)

15035 THE SOLAR WIND GEOMAGNETIC FIELD BOUNDARY. David B. Beard (Goddard Space Flight Center, Greenbelt, Md.). 64p. (CONF-417-9)

From American Physical Society Meeting, Pasadena, Calif., Dec. 1963.

The theory of the boundary of the cavity surrounding a magnetic dipole immersed in a steadily flowing stream of plasma is reviewed, and the various results compared with satellite observations of the termination of the geomagnetic field. The shape on the solar side is roughly hemispherical with some theoretical uncertainty over the poles, the shape on the antisolar side is probably raindrop shaped but depends critically on the direction and relative magnitude of the interplanetary magnetic field and possible nonadiabatic processes such as shock phenomena. (auth)

15036 INTERACTION BETWEEN THE SOLAR PLASMA WIND AND THE GEOMAGNETIC CAVITY. Lester Lees (California Inst. of Tech., Pasadena). New York, American Inst. of Aeronautics and Astronautics, 1964, Preprint 64-88, 11p, $1.00. (CONF-392-18).

From Aerospace Sciences Meeting, New York, Jan. 1964.

If the quiet-time interplanetary magnetic field near the earth is parallel to the solar wind, the adiabatic two-fluid equations show that the flow of this "collision-free" plasma

over the geomagnetic cavity is reducible to an equivalent hypersonic "blunt-body problem" in ordinary gasdynamics, including a bow shock ahead of the cavity. The shape of the converging "tail" portion of the geomagnetic cavity is determined by an equivalent gasdynamic expansion along the surface streamline. The length of the tail measured from the earth's center is about 54 earth-radii. At the aft end of the cavity the converging plasma flow is deflected back to the axial direction across an oblique tail or "wake" shock, which decays to an Alfven wave in a distance of 10 to 20 cavity diameters downstream, or about 300 earth-radii. The geomagnetic cavity leaves a wake of hot plasma in the solar wind, and a corresponding defect in magnetic field intensity; the mechanism of diffusion in this wake is not yet understood. The effects of a transverse component of the interplanetary magnetic field are illustrated by considering the flow along the stagnation line between the bow shock and the stagnation point on the magnetosphere. The axial velocity and plasma density both vanish at the stagnation point, while the transverse magnetic field reaches its maximum value there. This "outer" solution is joined smoothly to the anti-parallel geomagnetic field across a collision-free plasma sheath similar to the sheath studied previously. This discussion furnishes the necessary first step for the analysis of the flow and magnetic field around the magnetosphere. (auth)

Low Temperature Physics

Refer also to abstracts 14204 and 15014.

15037 (DMS-63-10) THE EFFECTS OF DISLOCATIONS AND DISLOCATION ARRAYS ON SUPERCONDUCTIVITY. Technical Report No. 9. T. W. Barbee, W. A. Little, and R. A. Huggins (Stanford Univ., Calif.). [1962]. 8p

Dislocations have been associated with the filamentary structure proposed as a mixed-state structure capable of producing plastic deformation effects observed in superconducting properties. The local enhancement of critical field about a dislocation due to its elastic strain field was calculated, together with the magnitude (from thermodynamic considerations) of the critical field necessary to form a filament in a parallel external magnetic field equal to the bulk critical field. The actual dislocation structure in Ta was also examined by transmission electron microscopy. The results indicate that the properties of high-critical-current, high-critical-field superconductors can be improved by forming an interconnected network of material having a locally attenuated electron mean free path. (D.C.W.)

15038 (IDA/HQ-63-1412(Vol.I)(p.53-75)) MAGNETIC ENERGY STORAGE USING SUPERCONDUCTING COILS. Z. J. J. Stekly (Avco Corp. Avco-Everett Research Lab., Everett, Mass.).

The use of superconducting inductors to store magnetic energy is investigated. The qualifications of some superconductors for this application are examined, and the mass of superconductor (a toroid) and the surface area of the dewar required to produce various magnetic fields are calculated, together with the required structural mass. System costs and weights are estimated, and energy removal is considered. The status of superconducting coils is also summarized. (D.C.W.)

15039 (IDA/HQ-63-1412(Vol.I)(p.76-9)) NOTE ON SUPERCONDUCTIVE INDUCTOR ENERGY STORAGE. Kenneth H. Fischbeck (Radio Corp. of America. RCA Labs., Princeton, N. J.).

The development of a method for depositing Nb_3Sn on substrates ranging from steel wire to ceramic cylinders and disks is noted. With a flexible substrate, the resulting product is also flexible. Electric current densities in this material are in excess of 10^5 amp/cm^2 for magnetic fields stronger than 150,000 gauss. A switching arrangement for charging and discharging storage devices is also illustrated. Field containment, energy density, and geometrical considerations of energy storage are indicated. (D.C.W.)

15040 (IDA/HQ-63-1412(Vol.I)(p.80-4)) RCA CHEMICALLY-DEPOSITED SUPERCONDUCTING NIOBIUM–TIN (Nb_3Sn). J. J. Hanak (Radio Corp. of America. RCA Labs., Princeton, N. J.)

A chemical vapor-deposition process was developed for continuous deposition of Nb_3Sn film onto a moving metallic ribbon substrate. The resulting ribbon is strong and flexible. A 10-gauss solenoid has been constructed of Nb_3Sn-coated Pt substrate. Nb_3Sn can also be deposited on large ceramic and metallic substrates of various geometries. (D.C.W.)

15041 (IDA/HQ-63-1412(Vol.I)(p.106-9)) ENERGY STORAGE IN SUPERCONDUCTING SOLENOIDS. J. K. Hulm (Westinghouse Electric Corp. Research Labs., Pittsburgh).

The minimum cost per unit of energy stored in the coil is estimated, together with the maximum energy per unit volume. The requirements on the solenoid to meet these maxima and minima are also given, and the minimum winding thickness is estimated to be 1 cm. Difficulties with superconducting solenoids are indicated. (D.C.W.)

15042 (IDA/HQ-63-1412(Vol.I)(p.110-11)) A CRYOGENIC SYSTEM TO REFRIGERATE A SUPERCONDUCTING INDUCTOR. (Air Products and Chemicals, Inc., Allentown, Penna.).

The cryogenic system required to maintain at 4.4°K a superconducting inductor capable of storing the desired amount of energy was studied. A magnet consisting of a hollow cylinder 0.8 cm thick, 7 m in diameter, and 7 m long and contained in a spherical dewar 32 ft in diameter was considered. A 1.4 kw helium refrigerator operating only 2% of the time apparently can provide the required cooling. The cost of such a system was estimated to be at least 10^6 dollars. (D.C.W.)

15043 (JINR-P-1517) ASIMPTOTICHESKOE VYCHISLENIE FUNKTSII GRINA V PRIYLIZHENII VYAZKOI ZHIDKOSTI DLYA SVERKHTEKUCHIKH BOZE-SISTEM. (Asymptotic Calculation of the Green Function of Viscous Liquid Approximation for Superfluid Bose-Systems). Z. Galyascvich (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 38p.

The new method suggested by N. N. Bogolubov for calculating the Green functions in the ideal liquid approximation was used to obtain the Green functions in the viscous liquid approximation. These functions were obtained on the basis of hydrodynamic equations for viscous superfluid liquid as averaged equations of motion of Bose particle systems and on the basis of a relation between the mean values and the retarded Green functions. This approximation allows us to take into account the damping effects. The damping coefficients are expressed in terms of the kinetic coefficients (of the usual and second viscosity and thermal conductivity). (auth)

15044 (LADC-5956) THE USE OF MODERATELY HIGH PRESSURES AT CRYOGENIC TEMPERATURES. F. J. Edeskuty and R. L. Mills (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract W-7405-eng-36. 36p. (CONF-393-1)

From American Institute of Chemical Engineers Symposium on Techniques at High Pressures, Memphis, Feb. 1964.

The application of moderately high pressures to work at low temperatures is described. The problems involved in the merging of these two disciplines are discussed as they relate to laboratory research as well as to large scale nuclear rocket testing facility usage. The equipment used to determine some physical properties of liquid cryogens up to 50000 lb/in.^{2} are also described. The methods of obtaining and applying the low temperature to the high pressure volume will be mentioned. The use of a reciprocating piston pump to pump cryogenic liquids to high pressures is described. Consideration is also given to the problems of cryogenic seals for large size vacuum jacketed cryogenic piping. Safety requirements are also mentioned. (P.C.H.)

15045 HIGH-FIELD Nb_3Sn SUPERCONDUCTING MAGNETS BY MAGNETIC-FIELD STABILIZATION. E. R. Schrader (Radio Corp. of America, Princeton, N. J.), N. S. Freedman, and J. C. Fakan. Appl. Phys. Letters, 4: 105-6 (Mar. 15, 1964).

The production of critical currents in Nb_3Sn coils by providing coil stability in a background field is reported. The Nb_3Sn magnet yielded 92 kgauss in a 1.27-cm ID winding at 4.2°K. A small 210-gauss/amp coil was operated up to straight-sample critical currents with an inner field of over 100 kgauss when operated in a background field of 80 kgauss. (C.E.S.)

15046 A POSSIBLE EXPERIMENT USING THE MÖSSBAUER EFFECT IN SUPERCONDUCTORS OF THE SECOND TYPE. Gobalakichéna Sarma (Centre d'Etudes Nucleaires, Saclay, France). Compt. Rend., 258: 1461-3 (Feb. 3, 1964). (In French)

An experiment using the Mössbauer effect is proposed to show and measure the oscillation amplitude of the magnetic field at the interior of a superconductor of the second type in the "mixed" phase characterized by the presence of "vortex lines." It is shown that the effect of widening of the Mössbauer ray, because of the inhomogeneity of the field to which the nuclear spins are exposed, is of the same order of magnitude as the recoilless 6.25-kev γ radiation of Ta^{181}. (tr-auth)

15047 SUPERCOOLED COILS PROMISE INDUCTIVE ENERGY STORAGE. P. R. Wiederhold and D. L. Ameen (Ion Physics Corp., Burlington, Mass.). Electronics, 37: No. 11, 75-6; 79(Mar. 13, 1964).

The advantages and capabilities of inductive storage in superconducting coils are discussed. The properties of Nb-25% Zr for storage are discussed. (R.E.U.)

15048 MAXIMUM AVERAGE ENERGY DENSITY AS THE CRITERION FOR PHASE TRANSITION IN THIN SUPERCONDUCTIVE FILMS. Kuang Liu Cheng (Burroughs Corp., Paoli, Penna.). J. Appl. Phys., 35: 1302-5 (Apr. 1964).

For recent experimental results on thin superconductive films, the maximum average energy density as a macroscopic criterion of superconductivity is in better agreement with observed behavior than are any of the earlier criteria — maximum magnetic field, maximum current density, or maximum energy density. The earlier criteria are briefly reviewed, and characteristic formulas and critical curves are applied to an example for comparison with the proposed criterion. (auth)

15049 SUPERCONDUCTIVITY IN THE HIGH-PRESSURE InSb-BETA-Sn SYSTEM. Susan D. Nye, Mario D. Banus, and Harry C. Gatos (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 35: 1361-2(Apr. 1964).

The superconducting transition temperature of $InSb_{II}$ was found to increase to 4.4°K by alloying with β-Sn. (R.E.U.)

15050 EFFECTS OF PHONON PULSES ON THE ENERGY GAP IN A SUPERCONDUCTOR. P. R. Auvil, Jr. (Stanford Univ., Calif.). Nuovo Cimento (10), 31: 798-808 (Feb. 16, 1964).

The Bogoliubov theory is used to analyze a superconductor into which a large pulse of high-frequency (about 10^{11} Hz) phonons was injected. The discussion is restricted to the case where the phonon distribution has time-reversal symmetry in momentum space. It is assumed that T = 0°K and that absorption of the phonons is negligible. For reasonable pulse sizes (about 10^{15} phonons/cm^3) it is found that the energy gap changes by one part in 10^5 at an angle almost perpendicular to the direction of the phonon pulses. All other effects are of order one part in 10^9. The particular crystal structure of the solid is not taken into account. (auth)

15051 OSCILLATIONS IN ULTRASONIC ATTENUATION BY SUPERCONDUCTING TIN. L. T. Claiborne and N. G. Einspruch (Texas Instruments Inc., Dallas). Phys. Letters, 8: 160-2(Feb. 1, 1964).

Observation and interpretation of oscillations in the temperature dependence of the ultrasonic attenuation by type I superconducting tin are reported. (R.E.U.)

15052 MICROWAVE MAGNETOIMPEDANCE OF SUPERCONDUCTING TIN. R. T. Lewis (Univ. of California, Berkeley) Phys. Rev., 134: A1-9(Apr. 6, 1964).

Measurements, using a bimodal cavity, of the temperature and magnetic field dependence of the surface impedance of a single crystal of superconducting tin at a frequency of 23.5 Gc/sec are reported. In the geometry used, the static and microwave magnetic fields were parallel over the surface of the sample. The temperature dependence of the reactance in zero field agrees well with that calculated by Miller from the BCS theory. A small unexpected knee in the temperature dependence of the resistance is observed, centered around a reduced temperature of t = 0.88. This knee may arise from a band of p electrons with a smaller energy gap whose temperature dependence differs markedly from the BCS form, as proposed by Suhl, Matthias, and Walker. The change of surface resistance with applied field is found to be negative in the temperature range of the knee with the greatest negative dependence occurring at the center of the knee. The change of resistance is found to be positive outside this temperature range. The change of reactance with field is found to be positive. The association of the negative field dependence of the surface impedance with a band of p electrons is shown to give a qualitative explanation of the field dependence. (auth)

15053 SIMPLE MODEL FOR THE SUPERCONDUCTIVITY OF LANTHANUM AND URANIUM. C. G. Kuper, M. Antony Jensen, and D. C. Hamilton (Univ. of California, La Jolla). Phys. Rev., 134: A15-21(Apr. 6, 1964).

It is postulated that La and U have a narrow *f* band above, but very close to, the Fermi surface. An exchange interac-

tion, antiferromagnetic in sign, between electrons in the *f* band can lead to nonzero occupation of the *f* levels in a BCS-type wave function. This f-band condensation, through a weak coupling of the f band to the conduction band, enhances a BCS condensation of the conduction electrons. There are two energy gaps, for quasiparticle excitations in the two bands. The critical field at zero temperature is calculated, as is the transition temperature. The predicted isotope effect is extremely small. The ratio between the transition temperature and the energy gap at T = 0 depends on the numerical values of the parameters; although this ratio is of order unity, it would not be expected to be too near the BCS value of 1/1.75. (auth)

15054 SUPERCONDUCTIVITY IN INDIUM ANTIMONIDE. T. F. Stromberg and C. A. Swenson (Ames Lab., Ames, Iowa). Phys. Rev., 134: A21-3(Apr. 6, 1964). (IS-730)

Two samples of the metallic phase of indium antimonide were stabilized at atmospheric pressure by cooling semiconductor grade material from 100°C to 77°K at a pressure of 27 kbars, and then removing the pressure. Measurements of the magnetic moment of these samples down to 1.1°K were made using a sample-motion technique in a uniform magnetic field. Below 1.89°K, the samples exhibited bulk superconducting properties, in agreement with previous work. A high-field tail on the magnetization curves and the existence of considerable locked-in flux as the magnetic field was reduced were taken to be indications of a high state of residual strain in the sample. The slope of the critical field curve at 1.89°K was found to be $(\partial H_c/\partial T)_{Tc} = -103G/°K$. This is consistent with values found for soft superconductors with similar transition temperatures, and implies a normal state electronic specific heat per cm^3, which is roughly half that of white tin. White tin has the same average ionic mass as metallic indium antimonide, and presumably the same electronic density. (auth)

15055 SIZE EFFECTS IN THIN FILMS OF V_3Ge, Nb, AND Ta. J. J. Hauser and H. C. Theuerer (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 134: A198-205 (Apr. 6 1964).

An enhancement of the critical field of V_3Ge, Nb, and Ta was achieved by reducing the effective coherence length of these materials. This change in the coherence length was obtained in Nb and Ta by changing the grain size and therefore, the mean free path of the bulk material. Such a study yields also an experimental estimate of the coherence length of the bulk material which is in fair agreement with theoretical calculations. Thin films of V_3Ge, Nb, and Ta were obtained in thicknesses ranging from 200,000 to 100 Å. The V_3Ge films were produced by the hydrogen reduction of the mixed chlorides and by a new method called getter sputtering. The Nb and Ta films were sputtered. In all cases, MgO wafers were used as substrates. The critical temperatures of the films were approximately that of the bulk, although the thinner films always displayed slightly lower critical temperatures. The transition field of the films, measured by a resistance technique, was found to increase as the thickness of the films decreased. In conjunction with the transition field increase, a corresponding increase in the residual resistivity was observed, which implies a reduction in the mean free path. The departure of the transition magnetic field from the bulk value occurred at such large thicknesses (a few 10000 Å) that such a size effect cannot be explained in terms of the film thickness becoming comparable with the coherence length. This effect can be interpreted in terms of the very small grain size produced by sputtering films that, in turn, leads to a mean free path well below 100 Å. The presence of a sufficiently small grain size provides a means to produce negative surface energy superconductors with decreasing mean free path and consequently increasing Ginzburg-Landau parameter, without the addition of alloying elements. (auth)

15056 PERSISTENT CURRENTS IN SUPERFLUID HELIUM. John D. Reppy and David Depatie (Yale Univ., New Haven). Phys. Rev. Letters, 12: 187-9(Feb. 24, 1964).

The magnitudes of the persistent currents in superfluid helium were studied as a function of temperature between 2.10°K and the λ point. A two-fluid model is used. (R.E.U.)

15057 MAGNETIC FIELD OF A ROTATING SUPERCONDUCTOR. Alvin F. Hildebrant (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 12: 190-1(Feb. 24, 1964).

The detection and measurement of the magnetic field generated by rotation of superconducting lead films and foils are discussed. (R.E.U.)

15058 CONSERVATION OF THE FLUXOID. J. E. Mercereau and L. T. Crane (Ford Scientific Lab., Dearborn, Mich.). Phys. Rev. Letters, 12: 191-3(Feb. 24, 1964).

Experimental confirmation of a temperature variation of trapped magnetic flux consistent with adiabatic invariance of the quantum state for small temperature oscillations is presented. A two-fluid model shows that the electrons condense only into a particular current-carrying state, the flux changing in such a way as to keep the fluxoid constant. (R.E.U.)

15059 NUCLEAR MAGNETIC RESONANCE IN BISMUTH METAL AT 4.2°K. R. R. Hewitt and B. F. Williams (Univ. of California, Riverside). Phys. Rev. Letters, 12: 216-17(Mar. 2, 1964).

The measurement of the NMR spectrum of bismuth powder at 4.2°K is reported. Knight shift data are given. (R.E.U.)

15060 EXPERIMENTAL EVIDENCE FOR DELAYED ENTRY OF FLUX INTO A TYPE-II SUPERCONDUCTOR. A. S. Joseph and W. J. Tomasch (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Phys. Rev. Letters, 12: 219-22(Mar. 2, 1964).

Null-deflection torque magnetometer studies were carried out on annealed homogeneous Pb–Tl alloys (4.3 to 12.3 at.% Tl) in the form of thick films and foils over the interval $1.1 \leq T \leq 4.2°K$, with the applied field in the plane of the specimen. Flux-trapping characteristics were observed. (R.E.U.)

15061 THE CRITICAL MAGNETIC FIELD OF A SUPERCONDUCTOR. W. A. B. Evans and G. Rickayzen (Univ., Liverpool). Proc. Phys. Soc. (London), 83: 311-20(Feb. 1964).

The critical magnetic field of a Pippard superconductor is derived from the microscopic theory in a manner more satisfactory than the usual one. The free energy of the normal state only in magnetic fields above the supercooling field is used. At the same time, the supercooling field is calculated from a consideration of the stability of the normal state. The result agrees with that obtained earlier by Gor'kov from a calculation based on a microscopic derivation of the Ginsburg-Landau theory. (auth)

15062 INTERNATIONAL CONFERENCE ON THE SCIENCE OF SUPERCONDUCTIVITY. D. Douglas, Jr., and R. W. Schmitt, eds. Rev. Mod. Phys., 36: 1-331 (Jan. 1964).

Eighty-seven papers are included; separate abstracts have been prepared for 59. Twenty-six papers were previously abstracted in NSA. The two remaining papers discuss the history of superconductivity studies. (T.F.H.)

For abstracts of individual papers see: 14523, 14638, 15063, 15064, 15065, 15066, 15067, 15068, 15069, 15070, 15071, 15072, 15073, 15074, 15075, 15076, 15077, 15078, 15079, 15080, 15081, 15082, 15083, 15084, 15085, 15086, 15087, 15088, 15089, 15090, 15091, 15092, 15093, 15094, 15095, 15096, 15097, 15098, 15099, 15100, 15101, 15102, 15103, 15104, 15105, 15106, 15107, 15108, 15109, 15110, 15111, 15112, 15113, 15114, 15115, 15116, 15117, 15118, and 15119.

15063 MAGNETIZATION OF HIGH-FIELD SUPERCONDUCTORS. Charles P. Bean (General Electric Research Lab., Schenectady, N. Y.). Rev. Mod. Phys., 36: 31-9(Jan. 1964).

Experimental results and phenomenological theory based on the sponge model for hysteretic high-field superconductors are given. After developing the exposition for static magnetization, the response of the superconductors to alternating fields superimposed upon steady fields is studied. (T.F.H.)

15064 HARD SUPERCONDUCTIVITY: THEORY OF THE MOTION OF ABRIKOSOV FLUX LINES. P. W. Anderson and Y. B. Kim (Bell Telephone Labs., Inc., Murray Hill, N. J.). Rev. Mod. Phys., 36: 39-43(Jan. 1964).

The basic ideas of flux-creep theory (i.e., theory of motion of quantized flux lines) for hard superconductors are reviewed and evaluated. The qualitative predictions of this theory are compared with experimentally observed phenomena. (T.F.H.)

15065 RESISTIVE STATES OF HARD SUPERCONDUCTORS. Y. B. Kim, C. F. Hempstead, and A. R. Strnad (Bell Telephone Labs., Inc., Murray Hill, N. J.). Rev. Mod. Phys., 36: 43-5(Jan. 1964).

The magnetic properties of hard superconductors are studied in the so-called "resistive state," for which the Lorentz force parameter is far above the critical value specified by the Lorentz force relation $\alpha = J(H + B_0) \leq \alpha_c$, where α_c and B_0 are structure-sensitive constants of the material, H and J are the magnetic field intensity and current density, and α is the Lorentz force parameter. (T.F.H.)

15066 COLLECTIVE MODES OF VORTEX LINES IN SUPERCONDUCTORS OF THE SECOND KIND. P. G. De Gennes and J. Matricon (Faculté des Sciences, Orsay, France). Rev. Mod. Phys., 36: 45-9(Jan. 1964).

Collective modes of vortex lines (magnetic flux lines) in superconductors of the "extreme" second kind (in which the penetration depth is much larger than the coherence length) are considered. Dispersion relations for these modes are derived, and the effects of the modes on the physical properties of the material are discussed. (T.F.H.)

15067 ON DIFFERENT TYPES OF SUPERCONDUCTIVITY. K. Mendelssohn (Oxford Univ.). Rev. Mod. Phys., 36: 50-1(Jan. 1964).

The implications and physical meaningfulness of the sponge model in both types I and II superconductivity are discussed briefly. (T.F.H.)

15068 VARIATION OF THE CRITICAL FIELDS OF SUPERCONDUCTING LEAD WITH THE RESIDUAL RESISTIVITY. W. F. Druyvesteyn, D. J. Van Ooijen, and T. J. Berben (Philips' Gloeilampenfabrieken, N. V., Eindhoven, Netherlands). Rev. Mod. Phys., 36: 58-61(Jan. 1964).

The superconducting transition characteristics of Pb and Pb–In alloys are measured at 4.2°K. The effects of cold working and neutron irradiation on these characteristics are studied. (T.F.H.)

15069 PSEUDOREVERSIBLE MAGNETIZATION OF Nb. Harley C. Hitchcock (Varian Associates, Palo Alto, Calif.). Rev. Mod. Phys., 36: 61-4(Jan. 1964).

An experimental study of the reversibility of magnetization of a bulk sample of Nb is carried out. The results are in agreement with the concept that there is a superposition of a symmetric (paramagnetic/diamagnetic) defect magnetization on top of the ideal, reversible magnetization curve. The sample exhibits a temperature dependence of the upper critical field. (T.F.H.)

15070 AXIAL TORQUE IN TRAINED SUPERCONDUCTING WIRES IN A TRANSVERSE MAGNETIC FIELD. B. H. Heise (Union Carbide Corp., Tonawanda, N. Y.). Rev. Mod. Phys., 36: 64-6(Jan. 1964).

A torsion-balance method is used to measure the relaxation of magnetic moment in magnetized superconductors. The relaxation measurement is carried out for the purpose of calculating the magnetic-flux-pinning energies and total trapped magnetic flux in the superconductor. (T.F.H.)

15071 MAGNETIC AND RESISTIVE TRANSITIONS OF SOME Mo–Re ALLOYS. W. C. H. Joiner and R. D. Blaugher (Westinghouse Electric Corp., Baltimore). Rev. Mod. Phys., 36: 67-9(Jan. 1964).

Magnetic and resistive transitions in bulk samples of Mo–Re alloys (75 to 98% Mo) are measured. These alloys contain examples of both type I and type II superconductivity. (T.F.H.)

15072 TRANSVERSE MAGNETIZATION OF In–Sn FILMS. P. B. Miller, B. W. Kington, and D. J. Quinn (International Business Machines Corp., Yorktown Heights, N. Y.). Rev. Mod. Phys., 36: 70-3(Jan. 1964).

Transverse magnetization measurements are made on In–Sn films (0 to 7.1 at. % Sn) having thicknesses of 1900 to 3000 Å. The magnetic moments are measured, and the results are compared with hard-superconductor theory. (T.F.H.)

15073 SUPERCONDUCTING TANTALUM FILMS. J. J. Hauser and H. C. Theuerer (Bell Telephone Labs., Inc., Murray Hill, N. J.). Rev. Mod. Phys., 36: 80-3(Jan. 1964).

The upper critical field for sputtered superconducting Ta films can be explained in terms of an effective coherence length that is limited by the grain size of the film. This grain size increased from about 10 to 1000 Å as the deposition temperature was raised from 50 to 1400°C. The thin-film data are consistent with a coherence length of about 1000 Å for pure bulk Ta. (T.F.H.)

15074 THE INTERPHASE SURFACE ENERGY IN PURE AND IMPURE TANTALUM. S. L. Wipf (Westinghouse Electric Corp., Pittsburgh). Rev. Mod. Phys., 36: 83-6(Jan. 1964).

Studies are made of the superconducting transitions in pure (3 at. ppm impurities) and impure (0.03% impurities) Ta samples having diameters of 0.5 and 1.67 mm respectively. The temperature-dependent transition of these samples from type I to type II superconductivity is studied. (T.F.H.)

15075 SUPERCONDUCTING TRANSITION OF TIN ALLOYS IN AN ALTERNATING FIELD. J. G. Park (Imperial Coll. of Science and Tech., London). Rev. Mod. Phys., 36: 87-90(Jan. 1964).

An experimental study is made of the signal induced in a coil wrapped around a type I or type II In–Sn superconductor in a small alternating magnetic field superimposed on a steady field. The dependence of signal amplitude on field is investigated by sweeping the field through the superconducting transition and recording the results by photographing oscilloscope images. The magnetization and resistance are measured in the same way as a function of field. It is concluded that the major features of the signal can be accounted for by hysteresis effects. (T.F.H.)

15076 FIELD AND ANGULAR DEPENDENCE OF CRITICAL CURRENTS IN Nb_3Sn. [PART] II. G. D. Cody (RCA Labs., Princeton, N. J.), G. W. Cullen, and J. P. McEvoy, Jr. Rev. Mod. Phys., 36: 95-7(Jan. 1964).

The critical currents of superconducting cylindrical and planar films and whiskers of Nb_3Sn are measured in magnetic fields having various alignments with respect to the direction of the supercurrent. The measurements are carried out at 2.1 to 4.2°K. (T.F.H.)

15077 CRITICAL CURRENT AND FIELD IN NONIDEAL SUPERCONDUCTORS. A. El Bindari and M. M. Litvak (Avco-Everett Research Lab., Everett, Mass.). Rev. Mod. Phys., 36: 98-102(Jan. 1964).

Measurements are made on V, V–Ti alloys, and Nb–Zr alloys in order to show that the magnetic properties of type II superconductor are completely determined by the electronic heat capacity, the normal low-temperature electric conductivity, and the critical temperature. The results agree with the theory of type II superconductors. A laminar model is invoked to show that the three above-mentioned parameters also determine certain of the current-carrying properties of the superconductor. (T.F.H.)

15078 INFLUENCE OF PRESSURE ON THE SUPERCONDUCTIVITY OF SOME HIGH-FIELD SUPERCONDUCTORS. C. B. Mueller and E. J. Saur (Universitat, Giessen, Ger.). Rev. Mod. Phys., 36: 103-5(Jan. 1964).

Studies are made of the changes in the transition temperature and critical current of the superconductors Nb_3Sn, V_3Ga, and V_3Si in transverse magnetic fields up to 10 kOe and pressures of 0 to 1650 kg/cm^2, using the ice-bomb technique. (T.F.H.)

15079 MEAN FREE PATHS IN THE NORMAL AND THE SUPERCONDUCTING STATE. P. Wyder (Eidgenössische Technische Hochschule, Zurich). Rev. Mod. Phys., 36: 116-18(Jan. 1964).

Assuming the thermal conductivity of a system to be a function of the electronic mean free path, measurements of the thermal conductivity of a substance in the normal and superconducting states should indicate the magnitude of the mean free path in the superconducting state. These measurements are carried out for In wires and indicate within the experimental error that the electron mean free paths are the same in the normal and superconducting states. (T.F.H.)

15080 THERMODYNAMIC PROPERTIES OF A HIGH-FIELD SUPERCONDUCTOR. R. R. Hake (Atomics International, Canoga Park, Calif.). Rev. Mod. Phys., 36: 124-7(Jan. 1964).

Entropy, free energy, and magnetization are derived from specific heat data on a well-annealed bcc V–5 at.% Ta superconducting alloy. The alloy is in the bulk state. The magnetization and its relation with the effective field-dependent energy gap are in accord with the theory of type II superconductors. (T.F.H.)

15081 LATTICE HEAT CAPACITY OF SUPERCONDUCTING MERCURY AND LEAD. Norman E. Phillips, Marcel H. Lambert, and William R. Gardner (Univ. of California, Berkeley). Rev. Mod. Phys., 36: 131-4 (Jan. 1964).

It is assumed that the electronic and lattice heat capacities of superconductors are separable. Heat capacity measurements are carried out on superconducting Pb and Hg in order to determine whether the lattice specific heat of these substances is affected by the normal–superconducting transition. The implications of a change in the lattice heat capacity in the superconducting–normal transition in In, as regards the Debye-Waller factor for In, are discussed. (T.F.H.)

15082 SUPERCONDUCTIVITY IN THE TRANSITION METALS. T. H. Geballe (Bell Telephone Labs., Inc., Murray Hill, N. J.). Rev. Mod. Phys., 36: 134-8(Jan. 1964).

An outline is given of the superconducting properties of the transition metals (those having unfilled d shells and filled or empty f shells), using as examples the alloys Os–Ir, Os–Ru, Nb–Fe, Nb–Ru, and Nb–Os. (T.F.H.)

15083 ELECTRONIC STRUCTURE AND SUPERCONDUCTIVITY OF TRANSITION METALS AND THEIR ALLOYS. B. R. Coles (Imperial Coll. of Science and Tech., London). Rev. Mod. Phys., 36: 139-45(Jan. 1964).

The correlations between the electronic properties and superconducting properties of metals and alloys of the first, second, and third transition-metal series are outlined. (T.F.H.)

15084 SUPERCONDUCTIVITY AND ELECTRONIC PROPERTIES OF TRANSITION METAL ALLOYS. E. Bucher, F. Heiniger, J. Muheim, and J. Muller (Eidgenössische Technische Hochschule, Zurich). Rev. Mod. Phys., 36: 146-9(Jan. 1964).

The superconducting and calorimetric (e.g., electronic specific heat, Debye temperature, and atomic specific heat) properties of Ti–Zr, Nb–Re, Cr–Re, Nb, Nb–Ru, Nb–Os, Nb–Ir, Nb–Rh, Nb–Pt, Nb–Pd, V–Ti, V, Mo–Re, Mo, Ti, Nb–Mo, and Ti–Mo alloys were measured. Measurements were also made of the antiferromagnetic transition temperatures in the Cr–Re alloys, and the magnetic susceptibilities of some of the alloys. (T.F.H.)

15085 SUPERCONDUCTIVITY IN THE NbMo SYSTEM. R. A. Hein (Naval Research Lab., Washington, D. C.), J. W. Gibson, and R. D. Blaugher. Rev. Mod. Phys., 36: 149-52 (Jan. 1964).

The theoretical and experimental results for the superconducting properties of Nb–Mo alloys are correlated. (T.F.H.)

15086 BRILLOUIN ZONE EFFECTS IN SUPERCONDUCTIVITY. M. F. Merriam (Univ. of California, La Jolla). Rev. Mod. Phys., 36: 152-5(Jan. 1964).

Brillouin zone effects (interactions produced in cases in which the Fermi surface touches or overlaps the boundary of a Brillouin zone) are studied in superconducting Hg–In, Pb–In, and Sn–In alloys at 3.4 to 5.2°K. (T.F.H.)

15087 SUPERCONDUCTIVITY IN THE Y–Rh AND Y–Ir SYSTEMS. B. T. Matthias (Univ. of California,

La Jolla and Bell Telephone Labs., Inc., Murray Hill, N. J.), T. H. Geballe, V. B. Compton, E. Corenzwit, and G. W. Hull, Jr. Rev. Mod. Phys., 36: 155-6(Jan. 1964).

The superconducting transition temperatures of the alloys in the Y–Ir and Y–Rh alloy systems are given as a function of Y concentration. The question of the existence of a superconducting state in all nonferromagnetic metals is discussed. (T.F.H.)

15088 SHORT-RANGE SPIN SUSCEPTIBILITY OF SUPERCONDUCTORS. W. Baltensperger (Brown Univ., Providence). Rev. Mod. Phys., 36: 157-9(Jan. 1964).

In an adiabatic approximation the interaction of the conduction electrons with a rapidly varying magnetic potential is taken into account in the definition of the initial free one-particle waves for superconductors in small fields at 0°K. It is expected that the extension of this method to higher temperatures should lead to second-order phase transitions (i.e., superconductivity of the second kind). (T.F.H.)

15089 INTERACTION BETWEEN MAGNETIC IONS AND CONDUCTION ELECTRONS. S. Koide and M. Peter (Université, Geneva). Rev. Mod. Phys., 36: 160-2 (Jan. 1964).

The interactions between magnetic ions (rare earths or transition metals) and conduction electrons of the metallic matrix in which the magnetic ions are situated are studied theoretically, with emphasis on the superconductivity aspects. Results are calculated for the lanthanide ions. (T.F.H.)

15090 AC SUSCEPTIBILITY MEASUREMENTS ON TRANSITION METAL SUPERCONDUCTORS CONTAINING RARE EARTH AND FERROMAGNETIC METAL SOLUTES. Myron Strongin, E. Maxwell, and T. B. Reed (Massachusetts Inst. of Tech., Lexington). Rev. Mod. Phys., 36: 164-8(Jan. 1964).

The question of simultaneous ferromagnetism and superconductivity in $Gd_xTh_{1-x}Ru_2$ is studied, as is the apparent enhancement of superconductivity caused by the dissolution of small amounts of Fe or Ru in Ti. (T.F.H.)

15091 SUPERCONDUCTIVITY UNDER PRESSURE. J. L. Olsen (Eidgenössische Technische Hochschule, Zurich), E. Bucher, M. Levy, J. Muller, E. Corenzwit, and T. Geballe. Rev. Mod. Phys., 36: 168-70(Jan. 1964).

Pressure and isotopic effects on the superconducting critical temperatures of various metals are studied experimentally and theoretically. (T.F.H.)

15092 NUCLEAR MAGNETIC RESONANCE AND RELAXATION IN SUPERCONDUCTING ALUMINUM. R. H. Hammond and G. M. Kelly (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Rev. Mod. Phys., 36: 185-7(Jan. 1964).

Changes of the Knight shift of an Al film (thickness about 200 Å) were measured as the film passes through the superconducting transition temperature (about 0.82°K) in a steady magnetic field of 3.8 kOe. The results are compared with those of V, Sn, and Hg samples. It is believed that the sample is in some sort of mixed superconducting–normal state. This mixed state possible has an effect on the results. The shape of the NMR line does not change in going from the normal to the superconducting state. (T.F.H.)

15093 SURFACE IMPEDANCE OF SUPERCONDUCTORS. J. R. Waldram (Cambridge Univ., Eng.). Rev. Mod. Phys., 36: 187-93(Jan. 1964).

Surface impedance theory and measurements at a few kMc or less on superconductors near the weak coupling limit (e.g., Sn) are reviewed. Discrepancies between theory and experiment are noted, and it is found that all these discrepancies can be explained in terms of anisotropy of the Fermi surface, anisotropy of the energy gap, and inexactness of the Bardeen-Copper-Schrieffer form for the energy gap. (T.F.H.)

15094 TUNNELING BETWEEN SUPERCONDUCTORS. J. M. Rowell (Bell Telephone Labs., Inc., Murray Hill, N. J.). Rev. Mod. Phys., 36: 199-200(Jan. 1964).

Using the tunneling technique, studies are made of both the density of states variation in superconductors and the magnetic field dependence of the Josephson current (i.e., the flow of Cooper pairs across an insulating barrier). The measurements are made on metal–insulator–superconductor and superconductor–insulator–superconductor junctions. (T.F.H.)

15095 THEORY OF ELECTRON TUNNELING. J. R. Schrieffer (Univ. of Pennsylvania, Philadelphia). Rev. Mod. Phys., 36: 200-4(Jan. 1964).

The theory of tunneling in metal–oxide insulator–superconductor sandwiches is reviewed. (T.F.H.)

15096 SINGULARITIES IN SUPERCONDUCTING TUNNEL JUNCTION I-V CHARACTERISTICS. D. J. Scalapino (Univ. of Pennsylvania, Philadelphia). Rev. Mod. Phys., 36: 205-7(Jan. 1964).

It is shown that the I–V characteristics of superconductor junction diodes can be used to provide a direct experimental determination of critical points of the phonon distribution in metals. (T.F.H.)

15097 PHONON-ASSISTED TUNNELING IN SUPERCONDUCTORS. Leonard Kleinman, B. N. Taylor, and E. Burstein (Univ. of Pennsylvania, Philadelphia). Rev. Mod. Phys., 36: 208-10(Jan. 1964).

Theoretical predictions and experimental results are compared for thermal-phonon-assisted tunneling in superconducting junctions. Pb–Pb junctions are used for the experimental studies. (T.F.H.)

15098 MULTI-PARTICLE TUNNELING BETWEEN SUPERCONDUCTORS. C. J. Adkins (Cambridge Univ., Eng.). Rev. Mod. Phys., 36: 211-13(Jan. 1964).

An explanation is presented of multi- (especially two-) electron tunneling in superconducting junctions. The single-electron process is also discussed. (T.F.H.)

15099 ANOMALOUS BAND GAP IN SUPERCONDUCTING Nb_3Sn. Y. Goldstein (RCA Labs., Princeton, N. J.). Rev. Mod. Phys., 36: 213-15(Jan. 1964).

The band gap of Nb_3Sn is measured by the tunneling method and is found to be far below the theoretically expected value. In view of the fact that the band gap calculated from the thermal conductivity agrees with the theoretical prediction, it is concluded that the apparent small band gap obtained by the tunneling method is a result of surface effects. (T.F.H.)

15100 COUPLED SUPERCONDUCTORS. B. D. Josephson (Cambridge Univ., Eng.). Rev. Mod. Phys., 36: 216-20(Jan. 1964).

The similarity between the nature of tunneling supercurrents and "normal" supercurrents is established theoretically, and experimental results are discussed. It is shown that many varied types of behavior of barriers between superconductors can be predicted on the basis of a few simple equations based on straightforward assumptions. These equations can be justified by the microscopic theory. (T.F.H.)

15101 BOUNDARY EFFECTS IN SUPERCONDUCTORS. P. G. de Gennes (Faculté des Sciences, Orsay, France). Rev. Mod. Phys., 36: 225-37(Jan. 1964).

The properties of layered structures of superconducting (and non-superconducting) materials are studied, with emphasis on the related boundary-value problems. The experimental results are summarized, and theoretical interpretations are proposed for them. (T.F.H.)

15102 EFFECT OF PARAMAGNETIC ATOMS ON THE ENERGY GAP OF SUPERCONDUCTORS. F. Reif and Michael A. Woolf (Univ. of California, Berkeley). Rev. Mod. Phys., 36: 238-40(Jan. 1964).

The effects of paramagnetic impurities in superconducting films, and of paramagnetic films superimposed on superconducting films, on the transition properties and superconducting energy gaps of these superconducting films are examined. The effects are studied by measuring the d-c resistivity (to determine the transition temperature) and the tunneling supercurrent (to determine the energy gap or density of states). (T.F.H.)

15103 THE EXISTENCE OF A SUPERCONDUCTING STATE IN SEMICONDUCTORS. Marvin L. Cohen (Univ. of Chicago). Rev. Mod. Phys., 36: 240-3(Jan. 1964).

It is suggested, on the basis of theoretical calculations, that it should be possible to find superconducting semiconductors. It is noted that many-valley semiconductors having high carrier concentrations afford the most promising group for testing. Theoretical results are predicted for Ge–Si. (T.F.H.)

15104 INFLUENCE OF IMPURITIES ON THE INTERACTIONS RESPONSIBLE FOR SUPERCONDUCTIVITY. Morrel H. Cohen (Univ. of Chicago). Rev. Mod. Phys., 36: 243-6(Jan. 1964).

The effects of resonance levels of impurities on the properties of superconductors are studied theoretically. Both spin-dependent and spin-independent resonances are considered. (T.F.H.)

15105 CONCEPT OF AN "INNER FIELD" IN THE THEORY OF SUPERCONDUCTIVITY. G. L. Sewell (Bartol Research Foundation, Swarthmore, Penna.). Rev. Mod. Phys., 36: 247-51(Jan. 1964).

The concept of "inner field" is applied to the superconducting state. An attempt is made to identify the inner field with the thermal average of some quantum-mechanical observable, and thereby to obtain a characterization of the structure of the superconducting state. This identification is made, and it allows the principal properties of superconductors (Meissner effect, persistent currents, flux quantization) to be deduced from the symmetry properties of the inner field and the requirements of thermodynamics. (T.F.H.)

15106 THE EFFECT OF QUASIPARTICLE DAMPING ON THE RATIO BETWEEN THE ENERGY GAP AND THE TRANSITION TEMPERATURE OF LEAD. Yasushi Wada (Univ. of Pennsylvania, Philadelphia). Rev. Mod. Phys., 36: 253-7(Jan. 1964).

It is proposed that quasi-particle damping is responsible for the experimentally observed (energy gap at 0°K/transition temperature) ratio of 4.1 for Pb, as opposed to the value of 3.5 predicted by BCS weak-coupling theory. Since the quasi-particle damping rate increases with temperature, it reduces the transition temperature much more than it reduces the energy gap, thereby increasing the ratio. (T.F.H.)

15107 ANISOTROPY OF THE ENERGY GAP IN NIOBIUM FROM ULTRASONIC MEASUREMENTS. E. Roland Dobbs and John M. Perz (Cambridge Univ., Eng.). Rev. Mod. Phys., 36: 257-60(Jan. 1964).

The ultrasonic method is used to measure the superconducting energy gap in a single crystal of Nb as a function of temperature and orientation. The results are compared with the BCS predictions and with the experimental results for Pb and Sn. (T.F.H.)

15108 ULTRASONIC ATTENUATION IN SUPERCONDUCTING LEAD. R. E. Love and R. W. Shaw (Rensselaer Polytechnic Inst., Troy, N. Y.). Rev. Mod. Phys., 36: 260-4(Jan. 1964).

The ultrasonic attenuation of lead is measured at various crystallographic orientations in magnetic fields and in zero field, at 2 to 20°K, in order to determine the superconducting energy gap. (T.F.H.)

15109 LONG-RANGE CORRELATIONS IN SUPERCONDUCTIVITY. W. A. Little (Stanford Univ., Calif.). Rev. Mod. Phys., 36: 264-8(Jan. 1964).

Long-range correlations and their effects on flux quantization in superconductors are studied. It is found that pair correlations (and a corresponding flux quantized in units of hc/2e) account for most of the observations. Evidence is found, however, for a cluster correlation with the flux quantized in units of hc/8e. (T.F.H.)

15110 FLUX QUANTIZATION AND PERSISTENT CURRENTS. T. I. Smith and H. E. Rorschach, Jr. (Rice Univ., Houston, Tex.). Rev. Mod. Phys., 36: 277-80 (Jan. 1964).

Estimates are given of the factors affecting the stability of supercurrents below the critical temperature. Measurements are made of the stability of persistent currents in a long hollow cylinder of superconducting Sn to test the validity of these estimates. Lifetime effects associated with the current decay are noted. (T.F.H.)

15111 DOES SUPERCONDUCTIVITY IMPLY FLUX QUANTIZATION? Brian B. Schwartz and Leon N. Cooper (Brown Univ., Providence). Rev. Mod. Phys., 36: 280-4 (Jan. 1964).

Formulations of superconductivity theory are discussed in which magnetic flux need not be quantized. The physical validity of these theories is discussed. (T.F.H.)

15112 CRITICAL CURRENTS IN THIN PLANAR FILMS. Rolfe E. Glover, III, and Howard T. Coffey (Univ. of North Carolina, Chapel Hill). Rev. Mod. Phys., 36: 299-302(Jan. 1964).

Plane rectangular films of superconducting Sn, which are thin compared to the 0°K penetration depth, were prepared. The currents and current densities necessary to restore the normal state in these films were measured as a function of temperature. The critical current density was found to vary as $(1 - t^2)^{3/2}$, in agreement with theory. The measurements indicate a 0°K critical current density on the order of 20 MA/cm^2, also in qualitative agreement with theory. (T.F.H.)

15113 CURRENTS IN THIN SUPERCONDUCTING FILMS: NONLINEAR EFFECTS. Catalin D. Mitescu (California Inst. of Tech., Pasadena). Rev. Mod. Phys., 36: 305-8(Jan. 1964).

Nonlinear effects in superconducting Sn films are studied by applying sinusoidal magnetic fields to the films and measuring the induced harmonic currents. Even harmonics do not appear. Both in-phase and out-of-phase components appear in the third harmonic. The measure-

ments are carried out quite near the transition temperature. The data indicate a second-order phase transition, probably of the nature of a type II superconductor. (T.F.H.)

15114 TEMPERATURE DEPENDENCE OF THE CRITICAL FIELDS OF THIN SUPERCONDUCTING FILMS. Arnold M. Toxen (International Business Machines Corp., Yorktown Heights, N. Y.). Rev. Mod. Phys., 36: 308-12(Jan. 1964).

A theory of superconductors is described that includes both strong-field and nonlocal effects, using the Pippard kernel. The theory is used in a study of the temperature dependence of the critical magnetic field. It is found that systematic discrepancies between the theory and experimental values exist, which are at least partly resolved if the Pippard kernel is replaced by the BCS kernel. (T.F.H.)

15115 MICROWAVE NONLINEARITIES IN THIN SUPERCONDUCTING FILMS. M. D. Sherrill and K. Rose (General Electric Research Lab., Schenectady, N. Y.). Rev. Mod. Phys., 36: 312-15(Jan. 1964).

A thin superconducting Sn film is placed across the opening of an X-band waveguide, so that the opening is completely covered. In a certain power range, the film transmission is found to be highly nonlinear, and third harmonics of the fundamental frequency are generated. No detectable second harmonic is generated. The film is unbiased. The waveguide frequency is 9.4 kMc. (T.F.H.)

15116 CRITICAL FIELDS AND HYSTERESIS EFFECTS IN TIN FILMS. J. P. Baldwin (Mullard Research Labs., Redhill, Surrey, Eng.). Rev. Mod. Phys., 36: 317-20(Jan. 1964).

Experimental measurements of critical magnetic fields and hysteresis effects in superconducting Sn films are compared with the predictions of a nonlocal modification of the Ginzburg-Landau nonlinear theory of superconductivity. This nonlocal theory assumes boundary conditions corresponding to diffuse scattering of electrons at the film surfaces. (T.F.H.)

15117 SUPERCONDUCTIVITY OF THIN FILMS OF NIOBIUM. H. London and G. R. Clarke (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Rev. Mod. Phys., 36: 320-3(Jan. 1964).

The critical currents of thin films (440 and 1050 Å) of Nb are measured as functions of temperature and magnetic field. The critical phenomena are discussed. (T.F.H.)

15118 FREE ENERGY OF COMPOSITE WIRES IN THE SUPERCONDUCTING STATE. D. P. Seraphim, F. M. D'Heurle, and W. R. Heller (International Business Machines Corp., Yorktown Heights, N. Y.). Rev. Mod. Phys., 36: 323-7(Jan. 1964).

The superconductivity of composites composed of Al-, Au-, and Ag-coated Pb and Pb–Bi filaments is studied. The free energies and magnetic susceptibilities of these composites are found. (T.F.H.)

15119 UNSOLVED PROBLEMS OF SUPERCONDUCTIVITY. A. B. Pippard (Cambridge Univ., Eng.). Rev. Mod. Phys., 36: 328-31(Jan. 1964).

A discussion is given of solved and unsolved experimental and theoretical problems in the field of superconductivity. (T.F.H.)

15120 A NEW LIQUID HELIUM REFRIGERATING PLANT USING TURBO-EXPANDERS. T. H. Liem. Sulzer Tech. Rev. (Switz.), 45: 121-5(1963).

A liquid helium (4.2°K) refrigerating system is described that employs only turbo-expanders, so that neither nitrogen or hydrogen precooling is required. (R.E.U.)

15121 ON THE PROPERTIES OF LIQUID HELIUM. R. A. Haefer. Sulzer Tech. Rev. (Switz.), 45: 126-38 (1963).

The thermodynamic properties of liquid helium-4 are reviewed. The two-fluid model for helium is discussed; the quantum mechanics of He^4 are considered. 32 references. (R.E.U.)

15122 APPLIED CRYOGENIC ENGINEERING. R. W. Vance and W. M. Duke, eds. University of California Engineering and Physical Sciences Extension Series. New York, John Wiley & Sons, Inc., 1962. 524p. $17.50.

Basic theory and applications of cryogenics are reviewed. The subjects taken up include: the properties and technology of cryogenic fluids; mechanical properties of materials at cryogenic temperatures; cryogenic thermometry and insulation; fluid flow and heat transfer; helium; liquefaction of O_2, N_2, and H_2; storage and transfer of cryogenic fluids; cryogenic equipment (vessels, transport trailers, transfer lines, etc.); safety in cryogenic systems; explosion hazards in liquid bipropellants; and performance and prospects of cryogenic space-vehicle fuels. (T.F.H.)

15123 THE JOSEPHSON EFFECT IN SUPERCONDUCTING TUNNELING. P. W. Anderson (Bell Telephone Labs., Murray Hill, N. J.). p.124-42 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

The theory of the Josephson effect in superconducting tunneling is presented. The thermal fluctuation energy and its effect on Josephson tunneling is also discussed. (C.E.S.)

15124 THE COUPLED ELECTRON–PHONON SYSTEM IN NORMAL AND SUPERCONDUCTING METALS. J. R. Schrieffer (Univ. of Pennsylvania, Philadelphia). p.143-65 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

The electron–phonon interaction in normal and superconducting metals is discussed, and the problem of how one should treat the electron–phonon system in superconductors when the coupling is sufficiently strong that the idea of a quasi-particle is not really appropriate is considered. (C.E.S.)

15125 THE SUPERCONDUCTING CONDENSATION ENERGY. D. J. Scalapino and J. R. Schrieffer (Univ. of Pennsylvania, Philadelphia). Pt. II, p.2-8 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N. C., University of North Carolina, 1963.

An expression is derived for the superconducting condensation energy. The derivation is based on a hamiltonian of an electron-ion system that includes terms for the bare conduction electron energy in terms of the occupation of Bloch states, the bare phonon energy, and the electron-phonon and electron-ion interactions. (C.E.S.)

15126 GAUSSIAN AVERAGE METHODS IN THE THEORY OF SECOND ORDER PHASE TRANSITIONS. J. S. Langer (Carnegie Inst. of Tech., Pittsburgh). Pt. I, p.11-24 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N. C., University of North Carolina, 1963.

The Gaussian average formalism is applied to the theory of second-order phase transitions. Two special systems are treated: a Fermi gas with weak attractive interactions, that is a superconductor and the Ising model of the ferromagnet. (C.E.S.)

15127 FABRICATION OF Nb_3Sn SUPERCONDUCTING ELEMENT. Ernest Buehler and John E. Kunzler (to Bell Telephone Labs., Inc.). U. S. Patent 3,124,455. Mar. 10, 1964. Filed Jan. 9, 1961.

Powdered Nb_3Sn and tin or niobium and tin are mechanically compacted at up to 1500°C for up to 50 hours to produce a continuous superconducting current path in a hollow cylinder. (R.E.U.)

Neutron Physics

15128 (AE-133) STUDIES OF WATER BY SCATTERING OF SLOW NEUTRONS. K. Skoeld, E. Pilcher, and K. E. Larsson (Aktiebolaget Atomenergi, Stockholm). Jan. 1964. 23p.

The quasielastic scattering peak in light water at room temperature was studied with neutrons of energy ~5×10^{-3} ev. The width and shape of the peak was determined by the time-of-flight technique at two scattering angles. If it is assumed that the broad inelastic spectrum is due to scattering by a monoatomic gas of mass 18, it is found that the quasielastic scattering is in good agreement with the predictions by the continuous diffusion model. Inelastic spectra were recorded up to 13×10^{-3} ev. Indications of two discrete energy transfers (8 and 14×10^{-4} ev) are observed in the 90° run. The results are discussed and compared with earlier observations. (auth)

15129 (AERE-R-4484) A COMPILATION OF THE SCATTERING LAW FOR WATER AT 22°C AND 150°C. B. C. Haywood (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1964. 20p.

The scattering law for H_2O at 22 and 150°C are presented in the form of listings of the experimental data. A consideration of the possible absolute and relative errors is also given and estimates of the best lines through the experimental points are listed for guidance. (auth)

15130 (EUR-358.i(Suppl.)) CODICE DESTHEC LISTING E FIGURE. (DESTHEC Code Listing and Figures). (European Atomic Energy Community). [1963]. 28p.

The listing for the thermal neutron diffusion program DESTHEC is presented. (D.C.W.)

15131 (EUR-532.e) A MULTI-DIMENSIONAL, MULTIGROUP, MULTIREGION, NEUTRON DIFFUSION CODE (ITERATIVE-VARIATIONAL APPROACH). M. Lunelli and G. Maggioni (Milan. Università). 1964. 170p.

The program LOUISE III, in FORTRAN for the IBM 7090, calculates the criticality constant and critical fluxes of multiregion (up to 25) reactors in the multigroup (up to 10) approximation. Calculations can be performed in up to 7 dimensions, and an iterative-variational technique is used. The diffusion differential equations considered are included, together with a sample problem and the FORTRAN listing. LOUISE III has given results in agreement with WHIRLAWAY, while requiring a much shorter execution time. (auth)

15132 (GA/Phys/63-7) A METHOD FOR CALCULATING NEUTRON AGE (thesis). Robert Edward Park (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Aug. 1963. 69p. (AD-419775)

A method for calculating neutron age values for any homogeneous, nonmultiplying medium is presented. The method accounts for the effects of both inelastic and anisotropic neutron scattering. In the derivation of the method, Fourier transform techniques are used to develop, from the multigroup diffusion model, two simple recursive formulas that generate group average neutron age. The group average neutron ages are then used to estimate the age as a continuous function of lethargy. The method is used to calculate the age to indium resonance from a U-235 fission source in some sample moderators (Be, BeO, C, $C_{12}H_{10}$, and H_2O). The quality of the results indicates that the method should provide good values of neutron age for use in reactor design calculations. (auth)

15133 (JEN-127-DF/I-39) ENFRIAMIENTO DES LOS NEUTRONES POR CAPTURA Y SU APLICACIÓN AL ESTUDIO DE SU TERMALIZACIÓN EN AGUA LIGERA. (Capture Cooling of Neutrons and Its Application to the Study of Neutron Thermalization in Light Water). F. Verdaguer (Spain. Junta de Energia Nuclear, Madrid). 1963. 101p.

The effective neutron capture cross section and diffusion constants for cadmium-light water solutions were measured by the pulsed neutron technique. Theory shows that a cooling effect occurs that changes the constants, the change depending on the mean square energy transfer (M_2) between neutrons and medium. An M_2 of 1.65 ± 0.49 cm^{-1} was obtained from the measurements. This value can be explained by assuming that the neutrons interact with complexes of water molecules, the apparent mass of the molecules being >18. A method for eliminating higher harmonics is also described. (auth)

15134 (NAA-SR-Memo-9017) PRELIMINARY ANALYSIS OF NEUTRON ELASTIC SCATTERING ANISOTROPY IN DEUTERIUM. Harry Alter and H. J. Lorenzi (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 1963. Contract [AT(11-1)-Gen-8]. 61p.

Based on the angular distribution data contained in the second edition of BNL-400, a preliminary analysis of deuterium was performed. The results of this analysis appear as sets of coefficients (which describe the degree of anisotropy in the elastic scattering of neutrons by deuterium) and a series of curves which help illustrate the analysis. (auth)

15135 (NAA-SR-Memo-9018) PRELIMINARY ANALYSIS OF NEUTRON ELASTIC SCATTERING ANISOTROPY IN LITHIUM. Harry Alter and H. J. Lorenzi (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 1963. Contract AT-11-1-GEN-8. 94p.

Based on the angular distribution data contained in the second edition of BNL-400, a preliminary analysis of lithium and its isotopes was performed. The results of this analysis appear as sets of coefficients (which describe the degree of anisotropy in the elastic scattering of neutrons by lithium and its isotopes) and a series of curves which help illustrate the analysis. (auth)

15136 (NAA-SR-Memo-9019) PRELIMINARY ANALYSIS OF NEUTRON ELASTIC SCATTERING ANISOTROPY IN BORON. Harry Alter and H. J. Lorenzi (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 1963. Contract [AT(11-1)-Gen-8]. 25p.

Based on the angular distribution data contained in the second edition of BNL-400, a preliminary analysis of boron was performed. The results of this analysis appear as sets of coefficients (which describe the degree of anisotropy in the elastic scattering of neutrons by boron) and a series of curves which help illustrate the analysis. (auth)

15137 (NAA-SR-Memo-9020) PRELIMINARY ANALYSIS OF NEUTRON ELASTIC SCATTERING ANISOTROPY IN

SODIUM. Harry Alter and H. J. Lorenzi (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 1963. Contract [AT(11-1)-Gen-8]. 29p.

Based on the angular distribution data contained in the second edition of BNL-400, a preliminary analysis of sodium and potassium was performed. The results of this analysis appear as sets of coefficients (which describe the degree of anisotropy in the elastic scattering of neutrons by sodium and potassium) and a series of curves which help illustrate the analysis. (auth)

15138 (NAA-SR-Memo-9021) PRELIMINARY ANALYSIS OF NEUTRON ELASTIC SCATTERING ANISOTROPY IN NICKEL. Harry Alter and H. J. Lorenzi (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 1963. Contract [AT(11-1)-Gen-8]. 24p.

Based on the angular distribution data contained in the second edition of BNL-400, a preliminary analysis of nickel was performed. The results of this analysis appear as sets of coefficients (which describe the degree of anisotropy in the elastic scattering of neutrons by nickel) and a series of curves which help illustrate the analysis. (auth)

15139 (NAA-SR-Memo-9023) PRELIMINARY ANALYSIS OF NEUTRON ELASTIC SCATTERING ANISOTROPY IN MOLYBDENUM. Harry Alter and H. J. Lorenzi (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 1963. Contract [AT(11-1)-Gen-8]. 32p.

Based on the angular distribution data contained in the second edition of BNL-400, a preliminary analysis of molybdenum was performed. The results of this analysis appear as sets of coefficients (which describe the degree of anisotropy in the elastic scattering of neutrons by molybdenum) and a series of curves which help illustrate the analysis. (auth)

15140 (NAA-SR-Memo-9024) PRELIMINARY ANALYSIS OF NEUTRON ELASTIC SCATTERING ANISOTROPY IN THORIUM. Harry Alter and H. J. Lorenzi (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 1963. Contract [AT(11-1)-Gen-8]. 28p.

Based on the angular distribution data contained in the second edition of BNL-400, a preliminary analysis of thorium-232 was performed. The results of this analysis appear as sets of coefficients (which describe the degree of anisotropy in the elastic scattering of neutrons by thorium-232) and a series of curves which help illustrate the analysis. (auth)

15141 (NAA-SR-Memo-9025) PRELIMINARY ANALYSIS OF NEUTRON ELASTIC SCATTERING ANISOTROPY IN URANIUM. Harry Alter and H. J. Lorenzi (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 1963. Contract [AT-11-1-GEN-8]. 92p.

Based on the angular distribution data contained in the second edition of BNL-400, a preliminary analysis of uranium was performed. The results of this analysis appear as sets of coefficients (which describe the degree of anisotropy in the elastic scattering of neutrons by uranium) and a series of curves which help illustrate the analysis. (auth)

15142 (NAA-SR-Memo-9026) PRELIMINARY ANALYSIS OF NEUTRON ELASTIC SCATTERING ANISOTROPY IN PLUTONIUM-239. Harry Alter and H. J. Lorenzi (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 1963. Contract [AT(11-1)-Gen-8]. 24p.

Based on the angular distribution data contained in the second edition of BNL-400, a preliminary analysis of plutonium-239 was performed. The results of this analysis appear as sets of coefficients (which describe the degree of anisotropy in the elastic scattering of neutrons by plutonium-239) and a series of curves which help illustrate the analysis. (auth)

15143 (NAA-SR-Memo-9027) PRELIMINARY ANALYSIS OF NEUTRON ELASTIC SCATTERING ANISOTROPY IN TUNGSTEN. Harry Alter and H. J. Lorenzi (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 1963. Contract [AT(11-1)-Gen-8]. 69p.

Based on the angular distribution data contained in the second edition of BNL-400, a preliminary analysis of tungsten was performed. The results of this analysis appear as sets of coefficients (which describe the degree of anisotropy in the elastic scattering of neutrons by tungsten) and a series of curves which help illustrate the analysis. (auth)

15144 (NAA-SR-Memo-9204) THE AIM-6 CODE. H. P. Flatt and Dorothy C. Baller (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 1964. Contract [AT(11-1)-Gen-8]. 103p.

AIM-6 is a general, multigroup, one-dimensional diffusion equation code with provisions for a 20 element library of microscopic cross sections, 18 groups, 101 mesh points, downscatter to as many as 5 lower groups. In addition to 5 criticality searches, one and two element concentration searches are included. Microscopic cross sections can be changed at execution time. It allows for input of macroscopic cross sections if desired. Several special decks are available. Also a version is available which performs a multigroup buckling iteration calculation for a right cylindrical reactor. (auth)

15145 (NAA-SR-Memo-9276) GRAVE — A GROUP CROSS SECTION AVERAGING PROGRAM. R. A. Blaine and J. S. Temple (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1963. Contract AT-11-1-GEN-8. 68p.

The computer program GRAVE designed to compute cross sections averaged over any given flux spectrum is described. Eleven cross section parameters are on tape, and from these some 20 group average cross sections can be formed. Special treatment is given to the resonance region via the incorporation of the ARES II program. The theory is presented, and use of the program is discussed. The program is in FORTRAN II for the IBM 7094. (auth)

15146 (RRA-M31) AN ANGULAR DEPENDENT ALBEDO FOR FAST NEUTRON REFLECTION CALCULATIONS. R. L. French and M. B. Wells (Radiation Research Associates, Inc., Fort Worth, Tex.). Nov. 1, 1963. For Oak Ridge National Lab., Tenn. Contract [W-7405-eng-26], Subcontract 2267. 31p. (CONF-187-46)

From American Nuclear Society Meeting, New York, Nov. 1963.

An albedo model for calculating the reflection of fast neutron dose from materials of low to moderate hydrogen content was developed through analysis of extensive Monte Carlo reflection data for iron, concrete, and three types of soil. The model is for reflection to a unit non-directional receiver and is of the form $\alpha(E_0) \cos^{4}\theta_0 \cos\theta$, where $\alpha(E_0)$ is a coefficient tabulated as a function of incident energy E_0 for the various materials; θ_0 is the angle of inci-

dence; and θ is the angle of reflection (both measured from the normal). The differential albedo, in units of reflected dose/steradian per unit incident dose, may be converted to a total albedo by multiplying by π. The total dose reflection albedo for normally incident fission neutrons was found to be closely approximated by $0.435\ (\Sigma_T - \Sigma_H)/\Sigma_T$, where Σ_T is the macroscopic total cross section of all elements of the material and Σ_H is the macroscopic cross section of the hydrogen of the material, both weighted by the fission spectrum. (auth)

15147 (TID-20170) MULTIPLYING MEDIUM ASYMPTOTIC SPECTRUM. R. E. Slovacek, E. R. Gaerttner, R. R. Fullwood (Rensselaer Polytechnic Inst., Troy, N. Y.); and D. R. Bach (Knolls Atomic Power Lab., Schenectady, N. Y.). [1963]. Contract AT(30-3)-328. 6p.

The scalar and surface asymptotic (in time) spectra for two multiplying media (water moderated and paraffin moderated) were calculated and compared with measurements by the pulsed source-chopper technique described previously. Calculated decay constants were also compared to prompt neutron die-away time measurements. (auth)

15148 (WAPD-TM-377) EQUATIONS AND PROGRAMS FOR SOLUTIONS OF THE NEUTRON GROUP DIFFUSION EQUATIONS BY SYNTHESIS APPROXIMATIONS. S. Kaplan, O. J. Marlowe, and W. R. Cadwell (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Dec. 1963. Contract AT(11-1)-Gen-14. 71p.

A method for constructing approximate solutions to the three-dimensional group diffusion equations using only one- and two-dimensional programs is presented. The computer programs that have been developed to carry out this construction are described, and instructions are given for their use. (auth)

15149 (WAPD-TM-407) RECAP-1—A MONTE CARLO PROGRAM FOR ESTIMATING EPITHERMAL CAPTURE RATES IN SLABS. N. R. Candelore and R. C. Gast (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Oct. 1963. Contract AT-11-1-GEN-14. 39p.

The program RECAP-1 calculates epithermal capture rates in a repeating series of slabs by the Monte Carlo techniques. The cross section calculations; the cross section library consisting of four HP isotopes, U^{235}, H, O, and Zr; and input data are described. Additional isotopes can be added to the library. Sample input forms are also included. (D.C.W.)

15150 (AEC-tr-6332) ON THE TRANSPORT OF NEUTRONS IN THE MANY-GROUP THEORY. P. P. Abbati Marescotti. Translated for Los Alamos Scientific Lab., N. Mex., from Atti Accad. Sci. Ist. Bologna, Classe Sci. Fis., Rend., 9: No. 1, 194-214(1961/62). 29p.

Neutron transport in a slowing-down, diffusing, and multiplying medium is analyzed. An existence and uniqueness theorem for the solution of the many-group equations for the neutron distribution function is proved. The determination of the distribution function is reduced to the solution of a system of Fredholm integral equations. Further, it is proved that there exists a physically significant representation for the distribution function consisting of a superposition of terms, each of which describe all the neutrons that have undergone the same number of collisions between the initial instant and the time t. (auth)

15151 SLOWING DOWN OF NEUTRONS. STUDY BY THE THEORY OF DISTRIBUTIONS. D. Eidelman (S.N.E.C.M.A., Suresnes, France). J. Nucl. Energy, Pt. A & B, 18: 45-7(Jan. 1964). (In French)

The slowing down of neutrons in a nonabsorbing moderator is treated by the theory of distributions. (D.C.W.)

15152 FAST NEUTRON DOSE MEASUREMENTS FOR A D–D NEUTRON SOURCE IN WATER. W. B. Beverly and V. Spiegel, Jr. J. Res. Natl. Bur. Std., 68A: 1-4 (Jan.-Feb. 1964).

The penetration of d–d neutrons in water was studied through measurements of first collision dose. A relative measurement of first collision dose as a function of distance from the neutron source was made at 0°C. At large penetrations the results appear to approach asymptotically a slope previously predicted for a monoenergetic, isotropic 4.0-Mev neutron source in water. However as expected, the measurements close to the source where the average neutron spectrum is relatively soft indicate a steeper slope than the theoretical calculation. Further calculations will be required to obtain an explicit check of the experiment. (auth)

15153 ON THE AGE OF NEUTRONS FROM FISSION IN WATER. L. N. Yurova, A. A. Polyakov, and A. A. Ignatov. Nekotorye Vopr. Inzh. Fiz., No. 4, 43-6(1963). (In Russian)

The question is considered as to whether absorption of neutrons in the source may account for differences between the calculated value for the age in water (to 1.47 ev) (26.0 ± 0.5 cm^2) and the measured value (27.3 ± 1.0 cm^2). Using a three-group method in a planar geometry with a source plate of U^{235} the slowing down of fission neutrons in water was calculated, allowing for absorption in the U^{235} plate at low energies. As an approximation in the middle energy range the correct Gaussian form for the spatial dependence of the slowing down density was replaced by a simple exponential having the same $\overline{r^2}$. It was found that for a zero plate thickness the calculated age is 26.9 cm^2, while for a thickness of 0.18 cm the calculated age is 31.8 cm^2. Thus, it was concluded that source absorption can account for the discrepancy. (TTT)

15154 APPLICATION OF SYNTHESIS TECHNIQUES TO PROBLEMS INVOLVING TIME DEPENDENCE. S. Kaplan, O. J. Marlowe, and J. Bewick (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 18: 163-76(Feb. 1964). (WAPD-T-1599)

A method described previously for synthesizing three-dimensional flux distributions is extended to reactor kinetics problems and to lifetime studies. The method is outlined, and some numerical examples are presented. The results of these show the method to be a practical way of solving time-dependent reactor problems with a detailed spatial model. (auth)

15155 TEMPERATURE DEPENDENCE OF NEUTRON-PULSE PARAMETERS IN H_2O. W. W. Clendenin (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 18: 351-62(Mar. 1964). (WAPD-T-1596)

The dependence of the decay time-constant of a thermalized neutron pulse in H_2O was calculated both as a function of buckling and of temperature for the range of temperatures between 23 and 300°C. Fair agreement between results and experiment for two moderator models was found for the dependence of the diffusion coefficient on temperature. For higher coefficients in the buckling expansion the agreement is poorer. A new iterative method applicable to any moderator model was used for the solution of the eigenvalue problem. This method is suited to high-order approximations to the transport equation, a P_{11} approximation having been used in the calculations. Convergence is rapid. An advantage is that the diffusion-cooled neutron fluxes are given accurately; these are presented and discussed. (auth)

15156 AN IMPROVED SPHERICAL-HARMONICS METHOD. W. R. Conkie (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 18: 370-5(Mar. 1964). (BNL-7315)

An iterative method was developed for the solution of neutron-transport problems. The method is formulated within the framework of a spherical-harmonics method. The method is developed first for one-group problems, then for more general velocity-dependent problems. The method is illustrated by application to the Milne problem for the one-group case and also to a velocity-dependent variation of the Milne problem. Good accuracy is obtained for both cases. (auth)

15157 NEUTRON-SPECTRUM MEASUREMENTS IN H_2O, CH_2 AND C_6H_6. J. C. Young, G. D. Trimble, Y. D. Naliboff, D. H. Houston, and J. R. Beyster (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 18: 376-99(Mar. 1964).

Neutron-spectrum measurements in several moderators were made with geometrical conditions approximating an infinite medium. The moderators studied were water, polyethylene, and benzene, and the absorbers dispersed in the moderators were boron, samarium, erbium, and gadolinium. The measurements are compared with predictions of the neutron spectra utilizing scattering models that take into consideration chemical binding. Measurements of scalar and angular neutron-energy spectra were made in a slab geometry water-moderated multiplying assembly at room temperature. The measured spectra are compared with DSN transport-theory calculations utilizing the Nelkin bound-hydrogen scattering model for water. (auth)

15158 THERMAL NEUTRON SPECTRA IN H_2O FOR PLANE GEOMETRY. Edgar Kiefhaber (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Sci. Eng., 18: 404-6 (Mar. 1964).

The thermal-neutron spectra in H_2O occurring in pulsed experiments were calculated. The energy-dependent Milne problem was treated using Nelkin's scattering kernel for water. The calculated energy distribution of neutrons at the interface was compared with a measured leakage spectrum from a large water geometry, and, because of the good agreement between theory and experiment, the leakage spectra of thermalized-neutron bursts was computed for slabs of finite thickness. The leakage spectra as well as the spectra in the center of the slabs show direct evidence for the diffusion cooling effect. (R.E.U.)

15159 DECOUPLING THE ENERGY-DEPENDENT SPHERICAL HARMONICS EQUATIONS. Bruce D. O'Reilly and Richard C. Lewis (Douglas Aircraft Co., Inc., Santa Monica, Calif.). Nucl. Sci. Eng., 18: 408-10(Mar. 1964).

The discrete energy approximation of the spherical harmonics equations for the slowing-down of gamma rays and elastically scattered neutrons is transformed to a system of spatially decoupled simultaneous differential equations. (R.E.U.)

15160 A NOTE ON THE MEASUREMENT OF THE TRANSPORT MEAN FREE PATH OF THERMAL NEUTRONS IN GRAPHITE BY A POISON METHOD. Glenn A. Price (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 18: 410-12(Mar. 1964). (BNL-7334)

The effect of diffusion cooling in the copper-poison method of calculating the transport mean free path for graphite (1.60 gm/cm^3) is considered. Comparisons are made between pulsed-neutron and poison methods. 10 references. (R.E.U.)

15161 DEGENERATE SOLUTIONS TO THE TRANSPORT EQUATION WITH ANISOTROPIC SCATTERING. Rubin Goldstein (Univ. of California, Berkeley). Nucl. Sci. Eng., 18: 412-13(Mar. 1964).

It is shown that for anisotropic scattering, the method of finding additional solutions to the homogeneous transport equation from degenerate solutions, by taking derivatives of the degenerate eigenfunctions with respect to the eigenvalues, is not always valid. Linear anisotropic scattering is considered for simplicity. (R.E.U.)

15162 STUDIES OF THE OPTICS OF NEUTRONS. IV. MAGNETIC SATURATION AND NEUTRON DEPOLARIZATION. Otto Halpern (Pacific Palisades, Calif.). Phys. Rev., 134: A126-7(Apr. 6, 1964).

It is suggested that the magnetic saturation of ferromagnets should be studied by a slight modification of the previously used method. Instead of measuring the retardation of the single transmission effect in incompletely saturated ferromagnets as a function of the magnetizing field, it is recommended to study the depolarization of a totally polarized beam passing through a ferromagnet. This study would be carried out by a measurement of the polarization of the transmitted beam and no longer by an intensity measurement. (auth)

15163 ON THE ENERGY DISTRIBUTION OF ONE-PHONON COHERENT SCATTERING OF MONOCHROMATIC NEUTRONS. V. N. Kashcheev (Inst. of Physics, Riga). Phys. Status Solidi, 4: 31-6(1964). (In Russian)

Calculations were made of the form of the peaks in the energy distribution of monochromatic neutrons scattered by an anharmonic crystal in a single-quantum process at low temperatures. Cubic anharmonicity and anisotropy of the linear dispersion law for acoustic phonons were taken into account. No specific model of the crystal field was used. The frequency dependence of the flanks on both sides of the maximum of the peak was calculated. The essential result was the general asymmetry of the flanks of the peak (relative to the type of the scattering crystal). (auth)

15164 IZOTOPNYE ISTOCHNIKI NEITRONOV. (Isotopic Sources of Neutrons). G. M. Fradkin. Moscow, Gosatomizdat, 1963. 88p.

A handbook is presented on handling and applications of portable neutron sources in laboratories and in the field. Tables are given of the neutron source parameters, physico-chemical characteristics of radioisotopes, and nuclear properties of materials for transforming α and γ emissions into fast neutron fluxes. (R.V.J.)

15165 REDUCTION OF TRANSPORT THEORY TO MULTIGROUP DIFFUSION THEORY. G. C. Pomraning (General Electric Co., San Jose, Calif.). 35p. (CONF-187-87; APED-4343).

From American Nuclear Society Meeting, New York, Nov. 1963.

The general linear Boltzmann equation, written so as to properly account for the thermal molecular motion of the medium, is used to obtain an exact derivation of the multigroup diffusion theory equations. The only assumptions utilized are those implicit in any multigroup diffusion theory scheme, i.e., the directional neutron density within each group is separable according to $n(\vec{r},v,\vec{\Omega}) = n(\vec{r},\vec{\Omega})n(v)$, and the angular dependence of $n(\vec{r},\vec{\Omega})$ is expandable in a truncated spherical harmonics series. The resulting equations are somewhat different (in structure and in the definition of the group constants) from the usual multigroup equations. The simple Fick's Law of diffusion is shown to not hold within each group; the molecular motion of the

medium must be accounted for in computing the group averaged cross sections as well as in computing the spectrum; the proper manner in which to compute the diffusion coefficient matrix is to energy-average the inverse of this matrix, i.e., the cross sections. A derivation (subject only to the single separability assumption implicit in multigroup theory) of the equation for neutron spectrum, needed to compute group averaged quantities, is given. (auth)

15166 ANGULAR DISTRIBUTION OF THE AIR-SCATTERED FAST-NEUTRON DOSE RATE AT THE AIR-GROUND INTERFACE. M. B. Wells (Radiation Research Associates, Inc., Fort Worth, Tex.). 18p. (CONF-187-90 RRA-N32)

From American Nuclear Society Meeting, New York, Nov. 1963.

The spatial and angular distributions of the fast-neutron dose rate in air as calculated by Monte Carlo methods are used to predict the results of fast-neutron dose rate measurements taken in unshielded vertical concrete-lined cylindrical holes at the ORNL-TSF. The agreement of the predictions with the measured data demonstrates that: (1) the air-scattered fast-neutron dose rate entering the holes is not appreciably affected by the presence of the air-ground interface, (2) the angular distribution of the air-scattered fast-neutron dose rate entering the holes for a given reactor angle does not vary significantly with distance for source detector separation distances between 100 and 450 ft, and (3) simplified calculational techniques based on the use of infinite-medium air-transport data for fast neutrons can be used to adequately predict the fast-neutron radiation environment incident upon and in the holes. (auth)

15167 A FIRST-LAST COLLISION MODEL OF THE AIR/GROUND INTERFACE EFFECTS ON FISSION NEUTRON DISTRIBUTIONS. R. L. French (Radiation Research Associates, Inc., Fort Worth, Tex.). 27p. (CONF-187-91 RRA-M32)

From American Nuclear Society Meeting, New York, Nov. 1963.

A method was developed for predicting the effect of an air/ground interface on the fast neutron flux or dose at large distances from a point isotropic source of neutrons in air. The method yields numerical values for functions $f(H_S)$ and $f(H_D)$ which may be used to express the fast neutron intensity as a function of source height H_S, receiver height H_D, and source-receiver separation distance R, in terms of the corresponding infinite air medium intensity I(R). Thus $I(H_S,H_D,R) = f(H_S)f(H_D)I(R)$. The method is called the "First-Last Collision Model" because it is based on the influence of the ground upon the distribution of "first" collisions of neutrons about the source and of "last" collisions about the receiver. Generalized numerical results were computed and means were developed for applying these results to specific cases of interest. Comparisons of these results to those derived from Monte Carlo calculations and from experiments performed at the ORNL Tower Shielding Facility and the Nevada Test Site indicate that the first-last collision model predicts the fraction of the infinite air medium intensity within 5 per cent in almost all cases. (auth)

15168 FAST NEUTRONS AT HIGH ALTITUDES. R. C. Haymes (California Inst. of Tech., Pasadena). 8p. (CONF-417-8)

From American Physical Society Meeting, Pasadena, Calif., Dec. 1963. 8p.

The production of neutrons by primary cosmic radiation and the associated albedo of the earth's atmosphere, the decay-in-flight contribution from neutrons to the Van Allen zones, the possible existence of solar neutrons, and the production of neutrons by solar protons during flares are discussed. (R.E.U.)

15169 SPECTRAL, ANGULAR, AND FLUX DISTRIBUTIONS FOR NEUTRONS IN SEVERAL MATERIALS. F. J. Allen and A. T. Futterer (Ballistic Research Labs., Aberdeen Proving Ground, Md.). 25p. (CONF-187-106)

From American Nuclear Society Meeting, New York, Nov. 1963.

Results are given as by-products of Monte Carlo calculations of neutron penetration. Angular distributions of transmitted neutrons are shown for borated polyethylene (8 wt% B_4C) and for water for incident energies up to 5 Mev. The energy-dependent flux is plotted as a function of material depth for concrete and iron for incident energy of 2 Mev, total flux is shown for concrete as a function of thickness. Spectra are shown for water, concrete, soil, and borated polyethylene transmission. (R.E.U.)

15170 NEUTRON GENERATOR. Otto Reifenschweiler (to North American Philips Co., Inc., New York). U. S. Patent 3,124,711. Mar. 10, 1964. Priority date May 5, 1959, Netherlands.

A neutron generator is described in which deuterons and tritons are accelerated toward a target electrode made of copper or silver with a titanium layer. (R.E.U.)

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Refer also to abstracts 14230, 14811, 14924, and 15473.

15171 (AEEW-M-414) THE NEUTRON CROSS-SECTIONS OF U-238 BETWEEN 0.001 AND 5.6 ev. Helen M. Sumner (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Dec. 1963. 7p.

Cross sections were determined for neutron elastic scattering and radiative capture by U^{238} at 0.001 to 5.6 ev. (C.E.S.)

15172 (AROD-1784:31) THEORY OF THE NUCLEAR SHELL MODEL. Final Report, September 18, 1960–September 17, 1963. S. A. Moszkowski (Army Research Office, Durham, N. C.). Contract DA-ORD-31-124-61-G382. 11p.

Research progress on nuclear structure, nuclear models, nuclear spectra, and other nuclear theory, as well as on N-N scattering and quantum mechanics is summarized. (D.C.W.)

15173 (BNL-7800) A STUDY OF THE NUCLEAR REACTIONS $Mg^{26}(p,t)Mg^{24}$ AND $Mg^{26}(He^4,He^6)Mg^{24}$. M. E. Rickey, H. E. Wegner, K. W. Jones (Brookhaven National Lab., Upton, N. Y.); B. M. Bardin, C. Hoot, and M. Kondo (Colorado. Univ., Boulder). Feb. 3, 1964. Contract [AT(30-2)-Gen-16]. 15p. (CONF-396-1)

From Symposium on Nuclear Spectroscopy with Direct Reactions, Argonne, Ill., Feb. 1964.

The angular distributions and spectra for the neutron pickup reactions $Mg^{26}(p,t)Mg^{24}$ and $Mg^{26}(\alpha,He^6)Mg^{24}$ at 28 and 40 Mev, respectively, are compared. The equality of the ground state pickup momentum transfers at 15° permits a study of the relative excitations for transitions to the discrete state observed. The ground (0^+), 1.37-Mev (2^+), 4.12-4.23 Mev (4^+-2^+), 5.22-Mev (3^+), and 6-Mev (4^+) states are compared. Unresolved structure at higher

energies is compared in terms of its gross properties. Higher charge particles—Li^6, Li^7, and perhaps Be^7—were also observed. The Li^6 and Li^7 yield was notably stronger than the He^6 yield, and the energy distribution showed marked structure. (auth)

15174 (CEA-2355) ETUDE DU SCHEMA DE DESINTEGRATION ET DES MOMENTS ANGULAIRES DES NIVEAUX EXCITES DU Pm 147 PAR DES MESURES DE SPECTROGRAPHIE ET DE CORRELATIONS ANGULAIRES (these). (Study of the Disintegration Process and of the Angular Moments of the Excited Levels of Pm-147 Using Spectrographic and Angular Correlation Measurements (thesis)). Claude Philis (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 87p.

The energies and relative intensities of fifteen gamma lines were determined by a direct spectrographic study. A previously unreported level at 77 ± 2 kev was identified. A coincidence study confirmed the positions of the excited levels of Pm^{147}. The 77-kev line was placed between the 409 and 490-kev levels. Angular correlation measurements permitted the assignment of angular moments of $5/2$, $7/2$, and $5/2$ to the 92, 409, and 532-kev levels and of $5/2$ or $7/2$ to the 685-kev level. The associated mixing coefficients were also obtained. (D.C.W.)

15175 (CEA-2379) PROTON PENETRABILITIES USING AN OPTICAL MODEL POTENTIAL. G. S. Mani, M. A. Melkanoff, and I. Iori (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 300p.

Proton penetrabilities and reaction cross sections, calculated with an optical model potential, are tabulated for all nuclei up to lead and for energies from 1 to 50 Mev. The formulas and parameters used in the calculations are summarized. (D.C.W.)

15176 (CERN-64-1) PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON HYPERFRAGMENTS, ST. CERGUE, MARCH 28-30, 1963. W. O. Lock, ed. (European Organization for Nuclear Research, Geneva). Jan. 2, 1964. 225p.

Separate abstracts were prepared for fourteen of the sixteen papers included. Two papers, on strong and weak interactions of bound hyperons(Λ) and hypernuclear physics, were previously abstracted in NSA. (D.C.W.)

For abstracts of individual papers see: 14799, 14800, 15177, 15178, 15179, 15180, 15181, 15182, 15183, 15184, 15185, 15186, 15187, and 15188.

15177 (CERN-64-1(p.7-16)) IDENTIFICATION METHODS FOR HYPERFRAGMENTS. R. G. Ammar (Northwestern Univ., Evanston, Ill.).

The identification of hyperfragments by analysis of production or decay configurations or by direct charge and mass measurements on the tracks is discussed. Some information on various decay modes is summarized. (D.C.W.)

15178 (CERN-64-1(p.17-51)) HYPERNUCLEI. R. Levi-Setti (Chicago. Univ. Enrico Fermi Inst. for Nuclear Studies).

The methods for identifying hypernuclei are discussed, and the information obtained from the study of hypernuclei is summarized. The determinations of binding energies and spins for various hypernuclei are also discussed. (D.C.W.)

15179 (CERN-64-1(p.53-62)) NON-MESONIC DECAY MODES. J. Sacton (Brussels. Université).

The nonmesonic decay of hypernuclei is considered to be the result of the stimulated decay of the hyperon(Λ^0) in the presence of nucleons. Experimental studies on these stimulation processes, particularly on the ratio of proton to neutron stimulation and on the variation of the nonmesonic to mesonic decay ratio as a function of the hyperfragment charge, are summarized. (D.C.W.)

15180 (CERN-64-1(p.63-74)) HYPERFRAGMENT STUDIES IN THE HELIUM BUBBLE CHAMBER. M. M. Block (Northwestern Univ., Evanston, Ill.); L. Grimellini (Bologna. Universita); W. Becker, et al. (Syracuse Univ., N. Y.).

The interactions $K^- - He^4 \rightarrow {}_\Lambda He^4 - \pi^-$, $K^- - He^4 \rightarrow {}_\Lambda H^4 - \pi^0$, and $K^- - He^4 \rightarrow {}_\Lambda H^3 - \pi^- - p$ were investigated. The relative K-Λ parity and spin of ${}_\Lambda H^3$, ${}_\Lambda H^4$, and ${}_\Lambda He^4$ were determined, and the ${}_\Lambda H^3$ lifetime was obtained. A ratio of the p and s channel amplitudes for $\Lambda^0 \rightarrow n + \pi^0$ was measured, and the ${}_\Lambda He^4$ decay modes were analyzed. Also, the nonmesonic decay rate of ${}_\Lambda H^4$ was determined. (D.C.W.)

15181 (CERN-64-1(p.75-84)) A METHOD FOR DETERMINING THE SPIN AND PARITY OF THE Y_1^*. M. M. Block (Northwestern Univ., Evanston, Ill.).

The rate of hyperfragment production in $K^- - He^4 \rightarrow Y_1^{*-} - He^3 \rightarrow \pi^- - {}_\Lambda He^4$ was investigated as a function of three level assignments ($s_{1/2}$, $p_{1/2}$, and $p_{3/2}$) for Y_1^*. The large differences predicted between the three assignments should facilitate assignment of the quantum numbers. The results also indicate that hypernuclear production is severely limited if the K is scalar, while the rates are insensitive to whether pseudoscalar K is captured from an s or p orbit. (D.C.W.)

15182 (CERN-64-1(p.85-7)) LIFETIME MEASUREMENTS OF ${}_\Lambda H^3$ AND ${}_\Lambda H^4$. L. Fortney (Wisconsin. Univ., Madison).

The hyperfragments were produced by mesons(K^-) at rest in the heavy liquid bubble chamber. Analysis of the events by three different methods gave values of 0.70×10^{-10}, 0.6×10^{-10}, and 0.63×10^{-10} sec for the H^3 lifetime and values of 1.9×10^{-10}, 2.0×10^{-10}, and 2.4×10^{-10} sec for the ${}_\Lambda H^4$ lifetime. The good agreement indicates a low background of three-body decays in the two-body sample. (D.C.W.)

15183 (CERN-64-1(p.89-112)) HYPERFRAGMENT PRODUCTION. J. Zakrzewski (Warsaw. Univ. Inst. of Experimental Physics).

The conditions in which hyperfragments can be produced are outlined, and those aspects of nuclear emulsion technique relevant to the observation of hyperfragment production are discussed. The main experimental results (largely recent) that have been obtained are then reviewed. (D.C.W.)

15184 (CERN-64-1(p.113-16)) HEAVY HYPERFRAGMENTS. D. H. Davis (London. Univ. University Coll.).

The bulk of the hyperfragments produced in fast meson(K^-) interactions with emulsion nuclei are the residual spallation products of silver and bromine and have masses of A = 50 to 100. An upper limit of about 35 Mev was obtained for the binding energy of these hypernuclei, and the nonmesonic to meson(π^-) ratio in the decay of heavy spallation hyperfragments was determined to be 3800/17. The neutron to proton stimulation ratio for the weak hyperon(Λ) interaction in these heavy hypernuclei was estimated to be about 1.6–2 and 4. (D.C.W.)

15185 (CERN-64-1(p.123-9)) EMISSION OF LIGHT FRAGMENTS FROM THE DISINTEGRATION OF HEAVY NUCLEI IN PHOTOGRAPHIC EMULSION CAUSED BY HIGH-ENERGY PARTICLES; FIRST COMPARISON WITH

HYPERFRAGMENT EMISSION. P. Cueer (Strasbourg. Université. Centre de Recherches Nucléaires).

The emission of fragments of charge 3, 4 and 5, particularly Be^8, Li^8, and Li^9, was compared with the emission of all hyperfragments of charge 3 and 4. The incident particles were 14 and 24-Bev protons, 17.2-Bev mesons(π^-), and 1.5-Bev mesons(K^-). Some results from mesons(π^-) stopping were also used. (D.C.W.)

15186 (CERN-64-1(p.117-20)) A DOUBLE HYPERFRAGMENT EVENT. J. Pniewski (Warsaw. Univ. Inst. of Experimental Physics).

The production of a double hyperfragment in the capture at rest of a hyperon (Ξ^-) produced in the interaction $K^- - n \rightarrow \Xi^- - K^0$ for 1.5-Bev/c mesons(K^-) incident on nuclear emulsion was observed. The subsequent analysis indicates that the double hyperfragment was probably either ${}_{\Lambda\Lambda}Be^{10}$ or ${}_{\Lambda\Lambda}Be^{11}$. (D.C.W.)

15187 (CERN-64-1(p.131-45)) PRODUCTION OF FRAGMENTS WITH CHARGE NUMBER Z = 4 – 9 IN THE INTERACTIONS OF PROTONS WITH HEAVY NUCLEI. O. V. Lozhkin and N. A. Perfilov (Akademiya Nauk S.S.S.R. Institut Radievyi).

Some investigations of the fragmentation process are summarized. Only those features related to the mechanism of the process and to hyperfragment production are considered. (D.C.W.)

15188 (CERN-64-1(p.173-90)) THE NUCLEAR WELL-DEPTH FOR Λ PARTICLES. B. W. Downs (Colorado. Univ., Boulder).

The calculations by Bodmer of the well-depth D in terms of two- and three-body Λ-N potentials without hard cores are reviewed, together with calculations of D in terms of two-body Λ-N potentials with hard cores. The relation between D and the properties that the optical potential for scattering of low-energy hyperons(Λ) by heavy nuclei might be expected to have is also considered. (auth)

15189 (CERN-64-12) PRODUCTION CROSS-SECTIONS OF TRITIUM AND RARE GASES IN VARIOUS TARGET ELEMENTS. K. Goebel, H. Schultes (European Organization for Nuclear Research, Geneva); and J. Zaehringer (Max-Planck-Institut für Kernphysik, Heidelberg). Mar. 2, 1964. 78p.

Tritium and rare gas production cross-sections for high-energy protons were measured in different materials, including complex materials such as olivine and stone meteorites, in order to estimate production rates and ratios of these isotopes in meteorites. To find the general behavior of the excitation functions, measurements were made between energies of 0.6 and 25 Bev. The influence on the cross-sections due to irradiation technique, monitoring cross-sections, and gas separation from the target was studied. Values are given for the cross-sections with absolute errors of 15%, and in some cases below 10%. Production ratios were determined from the cross-section measurements, and the final cross-section results were compared with expected values from Monte Carlo calculations and from Rudstam's spallation formulae. In general, agreement was satisfactory, although the parameters chosen for the stable isotopes in Rudstam's spallation formulae were slightly different from the values adopted for the radioactive isotopes. The results obtained also show in general good agreement with the predictions of the evaporation theory. 62 references. (auth)

15190 (CONF-187-76) FLUXES AND REACTION RATES IN THE PRESENCE OF INTERFERRING RESONANCES. C. N. Kelber (Argonne National Lab., Ill.). [1963]. Contract [W-31-109-eng-38]. 9p.

From American Nuclear Society Meeting, New York, Nov. 1963.

The effects of competition between resonances of different isotopes were investigated. Flux and reaction rate calculations on a $Pu^{239}-U^{238}$ system revealed that U^{235} exhibits both self-shielding and interference effects, the latter becoming noticeable at enrichments of a few per cent. Gold activation was also found to be depressed by the presence of U, but was insensitive at low enrichment values. Investigation of the Pu^{239} resonance integral showed an asymmetric effect involving both interference between potential and resonant scattering and interference with resonance absorption in another isotope. The interference scattering arising in each resonance level had a notable effect on the average change in the Doppler coefficient. (D.C.W.)

15191 (CONF-399-1) DIRECT REACTION STUDY OF THE Ca^{41} AND Ca^{49} SHELL-MODEL LEVELS. T. A. Belote, E. Kashy, A. Sperduto, H. A. Enge, and W. W. Buechner (Massachusetts Inst. of Tech., Cambridge). [Feb. 18, 1964]. Contract [AT(30-1)-2098]. 6p.

From Proceedings of the Symposium on Nuclear Spectroscopy, Argonne, Ill., Mar. 1964.

The shell-model level structures of Ca^{41} and Ca^{49} were studied by the stripping reactions Ca^{40}(d,p) and Ca^{48}(d,p). Single-particle level structure in the two nuclei was identified by a distorted-wave Born approximation analysis. The positions and spectroscopic factors of the levels are compared, and the possible role of shell-model hole states is also discussed. (auth)

15192 (CONF-399-2) AN ESTIMATION OF PION NUCLEAR ELASTIC CHARGE EXCHANGE SCATTERING. A. K. Kerman and R. Logan (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). [1962]. Contract AT(30-1)-2098. 8p.

From Proceedings of the Symposium on Nuclear Spectroscopy, Argonne, Ill., Mar. 1964.

The double elastic charge exchange scattering of pions on nuclei was estimated using an optical model potential. Assuming the impulse approximation, the optical potential was constructed by summing the π-N scattering amplitude over the nucleons of the nucleus. Only s- and p-wave contributions were considered, but the full isotopic spin independence was included. Preliminary results, which do not include Coulomb effects, are given for the double charge exchange cross sections of Fe, Sn, and Pb at 10, 20, 40, and 65 Mev. (auth)

15193 (CONF-417-13) A COMPUTER PROGRAM TO OBTAIN NUCLEAR MATRIX ELEMENTS. R. W. Newsome, Jr., H. J. Fischbeck, and W. M. Greenberg (Michigan. Univ., Ann Arbor. Harrison M. Randall Lab. of Physics). [nd]. Contract [AT(11-1)-1112]. 4p.

From American Physical Society Meeting, Pasadena, Calif., Dec. 1963.

A computer program is described which can be used to obtain nuclear matrix elements from the measured β spectrum shape factor, the β-γ directional correlation, and the β-γ circular polarization correlation in $3^- \rightarrow 2^+$ β transitions. Nuclear finite size effects are included by using exact electron radial wave functions. The program is written for the IBM 7090 digital computer in the compiler language known as MAD (Michigan Algorithmic Decoder). (auth)

15194 (EUR-483.e) DYNAMIC NUCLEAR POLARIZATION IN LIQUIDS AT HIGH MAGNETIC FIELDS. K. H. Hausser (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 15p. (CONF-424-1)

From 13th Annual Meeting of the Society of Physical Chemistry, Paris, June 1963.

The investigation of dynamic nuclear polarization (DNP) by relaxation interaction is extended both theoretically and experimentally from two types of spins to systems of three and more types of spins and to triple resonance. Also, the possibility of applying DNP for signal enhancement in high resolution NMR is investigated with particular attention to the high field limit of this mechanism. Measurements of the DNP at different temperatures and related measurements on line width and relaxation lead to the conclusion that the high field limit in a nonviscous solvent such as acetone at room temperature is of the order of 10 kgauss. (auth)

15195 (JINR-P-1486) NEKOTORYE EKSPERIMENTY PO UGLOVOMU RASPREDELENIYU REAKTSIYAKH PEREDACHI S IONAMI Ne^{20} I A^{40}. (Experiments on Angular Distribution in the Transfer Reactions with Ne^{20} and A^{40} Ions). E. Lozhinski (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1963. 22p.

A gamma-spectroscopy method was applied for investigating the angular distributions of the multinucleon transfer reactions in the interaction of complex nuclei. The end reaction products were identified both by characteristic gamma rays and the half life. To separate the end products of the transfer reaction from those of the compound nucleus decay a ring-shaped catcher foil consisting of three foils, one aluminum and two gold ones, was used. The angular distributions were obtained for the stripping and pick-up reactions (Ne^{20}, F^{19}), (Ne^{20}, Na^{24}), and (Ne^{20}, Na^{22}). As a target Cu^{63}, Cu^{65}, Rh^{103}, Ta^{181}, Au^{197}, and U^{238} were used. In bombarding Au^{197} target with Ar^{40} ions, there were observed the angular distributions for the reactions (Ar^{40}, Cl^{39}), (Ar^{40}, S^{38}), (Ar^{40}, Ar^{41}), and (Ar^{40}, K^{43}). The angular distributions obtained point to a strong dependence on Z of the target nucleus, on the type of reaction, and on the number of particles transferred. An attempt is made to interpret the obtained results by two mechanisms of the transfer reactions. (auth)

15196 (JINR-P-1530) REZONANSNII MEKHANIZM ISPUSKANIYA NEITRONOV PRI ZAKHVATE μ^--MEZONOV KISLORODOM. (A Resonance Mechanism of Neutron Emission in Muon Capture by Oxygen). V. V. Balashov, V. B. Belyaev, N. M. Kabachnik, and R. A. Eramzhyan (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 7p.

A resonance mechanism of neutron emission in the processes of muon capture by light nuclei is investigated. Detailed calculations are given for the reaction $\mu^- + O^{16} \rightarrow N^{15} + n + \nu$. It is shown that up to $E_n = 10$ Mev the resonance capture mechanism plays the main role in producing the neutron spectrum. (auth)

15197 (LAMS-2963) DOSE RATES, ACTIVITY, AND SHIELDING TRANSMISSION FACTORS FOR U^{235} FISSION PRODUCTS AFTER SHORT IRRADIATION. Donald A. McKown (Los Alamos Scientific Lab., N. Mex.). July 18, 1963. Contract W-7405-eng-36. 24p.

The calculated gamma dose rates and shielding dose transmission factors with buildup for U^{235} fission products are tabulated for various times after fission. The transmission factors are listed for lead, iron, concrete, aluminum, and water. The calculations are based on the U^{235} fission product gamma-ray spectra and activities presented by Ann T. Nelms and J. W. Cooper in Health Physics, V. 1, No. 4, (March 1959) 427–441. Point source geometry is assumed, and the buildup factors are for infinite media. (auth)

15198 (LAMS-2979) FAST NEUTRON INTERACTIONS WITH Li^6 AND Li^7. Louis Rosen (Los Alamos Scientific Lab., N. Mex.). July 18, 1963. Contract W-7405-eng-36. 28p. (CONF-13-9)

From American Physical Society 1963 Southwestern Meeting, Houston, Tex., Feb. 1963.

The cross sections for the reactions Li^6(n,dn)He^4 and Li^7(n,tn)He^4 over the incident neutron energy range of 5–14 Mev were measured. The energy and angular distributions of all reaction products were determined. (auth)

15199 (NAA-SR-Memo-9022) PRELIMINARY ANALYSIS OF NEUTRON ELASTIC SCATTERING ANISOTROPY IN YTTRIUM. Harry Alter and H. J. Lorenzi (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 1963. Contract [AT(11-1)-Gen-8]. 32p.

A preliminary analysis of anisotropic elastic scattering in yttrium was performed, using angular distribution data from the second edition of BNL-400. The results are presented as sets of coefficients describing the degree of anisotropy and as a series of curves that illustrate the analysis. (auth)

15200 (NAA-SR-Memo-9028(Rev.)) CROSS SECTION FOR LITHIUM ISOTOPES IN THE ENERGY RANGE 0.01 TO 15 Mev. Harry Alter and H. J. Lorenzi (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1963. Contract [AT(11-1)-Gen-8]. 86p.

Neutron cross sections (total, elastic scattering, and inelastic scattering), based on recent information, are presented for Li^6 and Li^7. Recent angular distribution data (elastic and inelastic) were analyzed to generate Legendre expansion coefficients and to produce a power series representing the cosine of the scattering angle. The analyzed information is presented in formats applicable to Monte Carlo shielding analysis. (auth)

15201 (NP-13648) ZERFALL DES Cl^{38}-ISOMERS. (Decay of Cl^{38}-Isomers). P. Kienle, K. Wien, F. Wunderlich, and R. Haas (Munich. Technische Hochschule). [1962]. 11p.

Isomeric Cl^{38} was produced by neutron activation of chlorine samples in a pneumatic irradiation facility. The decay of the Cl^{38} isomer was investigated by various scintillation spectrometer techniques. The half-life and the internal conversion coefficient α of the 0.66-Mev isomeric transition were found to be 0.74 ± 0.03 sec and $(5.0 \pm 1.2) \times 10^{-4}$, respectively. These data suggest a M-3 transition between an isomeric state with the spin $I = 5^-$ and the ground-state of Cl^{38} ($I = 2^-$). (auth)

15202 (NP-13678) SPECTROSCOPIE PAR DETECTEURS A SEMICONDUCTEUR DES REACTIONS NUCLEAIRES O^{16} + d, O^{18} + p (THESES). (Spectroscopy with Semiconductor Detectors of the Nuclear Reactions O^{16} + d, O^{18} + p (thesis)). Georges Amsel (Paris. Université). 1963. 114p.

The excitation curves and angular distributions of the reactions O^{16} + d and O^{18} + p were studied in the energy region from 0.8 to 2 Mev. The deuteron and α groups were detected by semiconductors, prepared by hot diffusion of Ga into n-type silicon. The preparation and properties of these detectors are discussed. The preparation of the oxygen targets by anodic oxidation of aluminum is also described. The experimental techniques used are discussed, and the results obtained are reported. The results showed the validity of the Breit-Wigner R matrix in the 9-Mev excitation region of F^{18} for the emission of α particles. The

selection rules of isotopic spin in the same region were verified for F^{18} and F^{19}. The (d,p) stripping theory at proton energies above 1 Mev was confirmed. (J.S.R.)

15203 (NP-13679) APPLICATION D'UN MODELE OPTIQUE POUR L'INTERACTION DU MESON π MESIQUE (THESE). (Application of an Optical Model to the Interaction of the π Meson with the Nucleus in the π Mesic Atom (thesis)). Maurice Berthet (Lyon. Universite). 1963. 59p.

The energy levels and their displacement ΔE with respect to that of a meson placed in a coulomb potential are determined and compared with the experimental values. This comparison permits the selection of values for the parameters introduced by the hypothesis of the optical model. The absorption in the nucleus is studied using the hamiltonian of the nucleon-π meson interaction and not the optical model. The results are compared with experimental values. As an introduction, the exact form of the interaction of mesons with nuclei is defined by adopting the optical model. (J.S.R.)

15204 (ORNL-TM-790) DIFFERENTIAL BREMSSTRAHLUNG CROSS SECTIONS FOR LOW-ENERGY ELECTRONS. J. D. Lawson (Oak Ridge National Lab., Tenn.). Feb. 1964. Contract W-7405-eng-64. 184p.

Bremsstrahlung cross sections were calculated for screened and nonscreened targets for electrons with energies from 0.05 to 5 Mev. The cross sections were obtained by numerical integration of the Bethe-Heitler equation for bremsstrahlung cross sections which are differential in photon energy and in proton and electron emission angles. Values of the bremsstrahlung cross sections which are differential in photon energy and doubly differential in photon energy and photon emission angle are tabulated. (auth)

15205 (TID-20132) LINEAR ACCELERATOR PROJECT. Progress Report, October 1963 through December 1963. E. R. Gaerttner (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. 57p.

Research progress on neutron inelastic scattering, fission, capture, strength functions, transmission, and thermalization is summarized. (D.C.W.)

15206 (TID-20224) ROTATION VIBRATION INTERACTION IN DEFORMED NUCLEI. Technical Report 345. Amand Faessler (Freiburg i. B. Universität); Walter Greiner (Maryland. Univ., College Park); and Raymond K. Sheline (Florida State Univ., Tallahassee). Dec. 1963. Contracts AT(40-1)-2434 and Nonr-1797(00). 42p.

The diagonalized rotation-vibration (RV) theory is tabulated in a form that is independent of the special parameters characterizing the individual nuclei. The collective hamiltonian of the RV theory is described, and the classification of basic and diagonalized states is discussed. The matrix elements required for the diagonalization are given, and some electric multipole operators and reduced matrix elements for transition probability calculations are obtained. Use of the formulas with the table is explained, and energies and mixing parameters extrapolated from the table for Sm^{152} and Os^{186} are compared with experiment and with exact diagonalizations. (D.C.W.)

15207 (TID-20225) NUCLEAR MODELS AND THE OSMIUM ISOTOPES. Technical Report 338. Amand Faessler (Freiburg i. B. Universität); Walter Greiner (Maryland. Univ., College Park); and Raymond K. Sheline (Florida State Univ., Tallahassee). Nov. 1963. Contracts AT(40-1)-2434 and Nonr-1797(00). 13p.

The experimental energies of the ground state rotational bands in Os^{186}, Os^{188}, and Os^{190} are compared with the predictions of the rotation-vibration (RV) model and the Davydov model with rotation-vibration interaction of the beta vibrations carefully considered. Advantages for the RV model are noted. Also, unprecedented excellent agreement between the experimental and theoretical values was achieved. (D.C.W.)

15208 (TID-20226) THE TWO-STEP (p,2p) REACTION. Technical Report 302. Robert W. Detenbeck (Maryland. Univ., College Park). May 1963. Contract [AT (30-1)-2464]. 25p.

A formal theory of two-step (p,2p) reactions was developed, based on a combination of the R-matrix theory of continuum states and the formal reaction theory appropriate to a direct (p,p′) reaction with final-state distortion. The formal theory yields an expression for the angular correlation between the two protons emerging from a two-step process involving an isolated intermediate state. This expression is obtained explicitly for the simplest plane-wave-Born-approximation description of the (p,p′) process. The effects of antisymmetric wave functions, neglected in the early parts of the paper, are discussed at the end in terms of the formal theory. (auth)

15209 (UCOL-521) AN INVESTIGATION OF THE LOW EXCITED 2+ STATES OF Cr^{52} (thesis). Roger Harrison Berger (Colorado. Univ., Boulder. Graduate School). 1963. Contract AT(11-1)-535. 55p.

The low excited states of Cr^{52} were investigated by studying the decays of V^{52} and isomeric Mn^{52} in order to determine which energy levels of Cr^{52} are 2+. The decays were studied by means of a singles and a coincidence gamma scintillation spectrometer. The study revealed the following gamma rays in the decay of V^{52}: 1.73 (0.13%), 1.53 (0.86%), 1.43 (100%), 1.33 (1.00%), 1.21 (0.33%), and the 1.73 (0.38%), 1.53 (0.92%), 1.43 (100%), 1.33 (0.35%), 1.21 (0.10%), 1.03 (0.38%), and 0.511 (70.0%) in the decay of Mn^{52m}. (The energies above are given in Mev and intensities as per cent of the 1.43-Mev transition.) The gamma rays were fitted into their respective decay schemes, which were found to be compatible with one another. With this information it was possible to assign spins and parities of 2+ to the 2.965 and 3.161-Mev levels of Cr^{52}. (auth)

15210 (UCRL-11193) ENERGY-MASS DISTRIBUTIONS AND ANGULAR MOMENTUM EFFECTS IN HEAVY-ION-INDUCED FISSION (thesis). Franz Plasil (California. Univ., Berkeley. Lawrence Radiation Lab.). Dec. 31, 1963. Contract W-7405-eng-48. 101p.

The energy and mass distributions of fission fragments in the reactions $O^{16}(Er^{170}) \rightarrow Os^{186}$, $C^{12}(Yb^{174}) \rightarrow Os^{186}$, and $O^{16}(W^{182}) \rightarrow Pb^{198}$ were measured. The results were interpreted in terms of the liquid drop model applicable to elements in this region. The energies of both fission fragments from each event were measured with solid-state detectors. Mass-total kinetic energy distributions were obtained from the energy data. Liquid drop calculations gave the gross features of the distributions and the nuclear temperature dependence of the widths quite well. Fission cross sections were calculated by evaluating fission widths and were fitted to measured cross sections. From the parameters used in the fits, average values for the nuclear temperature of the fissioning nuclei were obtained. (auth)

15211 (AEC-tr-6340) THE LEVELS OF Rh^{104} NUCLEUS EXCITED AT THE CAPTURE OF THERMAL NEUTRONS. L. V. Groshev, A. M. Demidov, G. A. Kotel'nikov, V. N. Lutsenko, and V. I. Pelekhov. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report IAE-517

presented at the State Committee for the Utilization of Atomic Energy, SSSR, Moscow, 1963. 12p.

The gamma and internal conversion spectra from the radiative capture of thermal neutrons by Rh^{103} were measured with magnetic spectrometers. From an analysis of the gamma spectrum, the neutron binding energy in Rh^{104} was determined to be 6998 ± 5 kev. Also, the appearance of 50 excitation levels in the energy region 0–2500 kev was established. In the conversion electron spectrum, only lines corresponding to radiative transitions with energies 97, 100, 127, 134, 181, 200, 203, 215, and 218 kev were detectable. Multipolarity was established for six of these transitions. (auth)

15212 (JPRS-23436(p.151-64)) QUADRUPOLE ENERGY LEVELS FOR SOME SPINS. V. S. Grechishkin and N. E. (Ye.) Aynbinder. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 6: 729-37(1963).

The quadrupole energy levels of nuclei with spins J = 2, 3, and 4 were calculated for the case of an arbitrary asymmetry parameter (η) of the gradient of the electric crystal field. For J = $^5/_2$, the zero-splitting parameters of the Zeeman spectrum of the nuclear magnetic resonance are tabulated for η = 0 to 1. Experiments were performed by the zero-splitting cone method on single crystals of $SbCl_3$ and $2SbCl_2 \cdot C_6H_6$ (resonance Sb^{121}, J = $^5/_2$). The asymmetry parameters η for the crystals were determined to be 0.15 and 0.10 respectively. (auth)

15213 SCATTERING OF FAST NEUTRONS IN THE COULOMB FIELD OF THE NUCLEUS. M. Croitoru (Institutul de Fizica Atomica, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 463-79(1963). (In Rumanian)

The first theoretical treatment of the scattering of charged particles in the Coulomb field of the nucleus was published by E. Rutherford; this resulted in an expression for the differential scattering cross section. Later, on the basis of Born's atom model H.A. Bethe and, independently, E. C. Bullard and H. S. W. Massey published a more rigorous nonrelativistic treatment of nuclear scattering. In 1947 G. Molière developed a theory, which was valid for scattering angles smaller than $\pi/2$ and for large incident energies. Today, the theory of N. F. Mott, based on Dirac's theory, is generally used. The theory was verified by a number of experimental studies; careful measurements were made by D. J. Anthony et al. The studies revealed the need for absolute nuclear scattering cross section measurements, covering a wider range of atomic numbers, scattering angles and incident energies, than previously used. The theory of multiple scattering was developed by E. J. Williams. Subsequent experimental work showed agreement between Williams's predictions in the case of light elements and with Molière's values for the heavier elements. (Review article, 33 references). (TTT)

15214 THE PROBABILITIES OF ISOMERIC TRANSITIONS IN ODD-ODD SPHERICAL ATOMIC NUCLEI. O. Dumitrescu (Univ. of Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 541-50(1963). (In Rumanian)

The probabilities for isomeric transitions in odd-odd spherical nuclei were calculated by taking the quantum nuclear model (with shells) as the basis, following the Moszkowski formulation. The contribution of the magnetic moment of the free neutron was considered. The theoretical results are compared with experimental data. (tr-auth)

15215 THE γ RAYS EMITTED DURING THERMAL NEUTRON CAPTURE IN INDIUM. V. Cojocaru (Inst. of Atomic Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 551-5(1963). (In Rumanian)

The γ spectrum below 800 kev from the reaction $In^{115}(n,\gamma)In^{116}$ was studied using a spectrometer with a single NaI(Tl) crystal. Gamma rays were found at 26, 69, 100, 152, 172, 196, 224, 246, 282, 311, 344, 391, 462, 555, 602, 645, 706, and 756 kev. The intensities of these rays were determined. Coincidence measurements were made on the 282-kev ray using a fast-slow coincidence scheme. (tr-auth)

15216 ZERO-POINT OSCILLATIONS IN THE NUCLEAR DROP MODEL. J. A. Castilho Alcarás, H. V. Fagundes, and P. Leal Ferreira (Instituto de Fisica Teórica, São Paulo, Brazil). Anais Acad. Brasil. Cien., 35: 299-308(Sept. 30, 1963).

The nuclear drop model is reviewed in connection with shape oscillations, neglecting compressibility effects. The zero-point fluctuations were then studied by calculating the root-mean-square (rms) radius of these oscillations and comparing it with the rms radii of some given mass distributions with diffuse boundary. A cutoff, analogous to the Debye cutoff in the continuum theory of specific heats of solids, was made in such a way that the number of collective degrees of freedom was equal to the number of particles in the surface. It was found that the surface thickness, as usually defined, is roughly independent of mass number, in agreement with the observed behavior as derived from the Stanford high-energy electron scattering experiments. This result suggested the collective nature of the effect. (M.C.G.)

15217 EMPLOYMENT OF A MULTICHANNEL MAGNETIC SPECTROGRAPH FOR STUDIES OF THE ELASTIC SCATTERING $V^{51}(d,d)V^{51}$ at E_d = 8.0, 8.5, 8.9, 9.4, 9.9, AND 10.5 Mev. J. Catalá, A. García, and R. Díez (Facultad de Ciencias, Valencia). Anales Real Soc. Esp. Fis. Quim. (Madrid), Ser. A, 59: 71-8(May-June 1963). (In Spanish)

The $V^{51}(d,d)V^{51}$ elastic scattering was studied at six different deuteron energies of 8.0, 8.5, 8.9, 9.4 and 10.5 Mev with a 24-channel magnetic spectrograph. The corresponding differential cross sections and angular distributions are shown in the angular range of 12°30′ to 175°. A Fraunhofer analysis of the ratio $\sigma_E(\alpha)/\sigma_R(\alpha)$ was carried out to obtain the black disk interaction radii. (auth)

15218 INTERACTIONS OF A BEAM OF He^3 PARTICLES AT 29 Mev WITH O^{16}. J. Aguilar, A. Sánchez, and A. García (Facultad de Ciencias, Murcia, Spain and Facultad de Ciencias, Valencia). Anales Real Soc. Esp. Fis. Quim. (Madrid), Ser. A, 59: 79-84(May-June 1963). (In Spanish)

Elastic scattering of 29-Mev He^3 particles by O^{16} was studied using the nuclear emulsion technique. Absolute differential cross sections in the center-of-mass system are given in the angular range 15 to 65°. The corresponding angular distribution was compared with theoretical Rutherford scattering and a value of 5.67 ± 0.29 fermis was obtained for the black disk interaction radius. (auth)

15219 DETERMINATION OF THE ACTIVATION CROSS SECTION OF SHORT-LIVED NUCLEAR ISOMERS FOR THERMAL NEUTRONS. K. F. Alexander and H. F. Brinckmann (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Ann. Physik (7), 12: 225-52(1963). (In German)

With the Rossendorf Research Reactor a method of pulse activation was developed for determining activation cross sections for short-lived isomeric nuclear states. Transition energies, half lives, and in some cases K conversion

coefficients were measured for the isomer levels. The experimental equipment and method are described. The results are: for $Na^{23}(n,\gamma)Na^{24m}$, $T_{1/2} = 20.3 \pm 0.2$ msec and $\sigma = 0.40 \pm 0.03$ barn; for $Ge^{70}(n,\gamma)Ge^{71m}$, $T_{1/2} = 20.0 \pm 0.6$ msec and $\sigma = 0.28 \pm 0.07$ barn; for $Ga^{71}(n,\gamma)Ga^{72m}$, $T_{1/2} = 36 \pm 1$ msec and $\sigma = 0.15 \pm 0.05$ barn; for $Se^{76}(n,\gamma)Se^{77m}$, $T_{1/2} = 17.7 \pm 0.03$ sec and $\sigma = 22 \pm 3$ barn; for $In^{115}(n,\gamma)In^{116m}$, $T_{1/2} = 2.16 \pm 0.02$ sec and $\sigma = 92 \pm 14$ barn; for $Er^{166}(n,\gamma) \times Er^{167m}$, $T_{1/2} = 2.27 \pm 0.05$ sec and $\sigma = 15 \pm 2$ barn; and for $Yb^{174}(n,\gamma)Yb^{175m}$, $T_{1/2} = 67 \pm 1$ msec and $\sigma = 46 \pm 4$ barn. From the ratio of the activation cross section to the absorption cross section, conclusions on the spin of the nuclear state were drawn. For Ga^{72} and In^{116} new proposals for an energy level scheme were obtained. For the remaining nuclei the previous spin arrangements were confirmed. (tr-auth)

15220 MEASUREMENT OF THE MASS OF Rn^{220} BY MASS SPECTROGRAPHY. F. Brouillard, A. Clinckemaillie, and J. M. Delfosse. Ann. Soc. Sci. Bruxelles, Ser. I, 77: 188-97(Dec. 20, 1963). (In French)

The mass of Rn^{220} was measured with a double-focusing mass spectrograph. The position of the Rn^{220} line was statistically localized by means of the alpha tracks emitted in a nuclear emulsion. Further, a least square method on four reference lines was used to minimize errors arising from uncertainties on the composition of the reference lines. The resulting mass value for Rn^{220} was 220.0808 ± 10 amu. (auth)

15221 THE ELASTIC SCATTERING OF NEUTRONS BY COMPLEX NUCLEI. THE OPTICAL NUCLEAR MODEL. S. Skavlem (Univ. of Bergen, Oslo). Arbok Univ. Bergen, Mat.-Nat. Ser., No. 9, 15p.(1962).

The exact theory for elastic scattering of unpolarized neutrons by complex nuclei is presented. Formulas for the elastic and reaction cross sections, the elastic angular distribution, and polarization degree are developed in terms of a partial wave analysis. The statistical compound nucleus model is introduced and applied to the case of many overlapping levels. It is shown how the elastic scattering can be split up into two different parts termed shape elastic and compound elastic scattering. Definitions of elastic transmission and decay probabilities are given. The assumption of random phases is shown to have the consequence that compound elastic scattered particles can not be polarized. (auth)

15222 ANGULAR DISTRIBUTION AND POLARIZATION OF NEUTRONS ELASTICALLY SCATTERED BY LEAD AND MOLYBDENUM NUCLEI. S. Skavlem and K. Myklebost (Univ. of Bergen, Oslo). Arbok Univ. Bergen, Mat.-Nat. Ser., No. 10, 19p.(1962).

The wave equation is solved for a potential consisting of a complex square well and a real Thomas spin-orbit term. This optical model is applied to the study of elastic scattering of unpolarized neutrons by lead and molybdenum nuclei at incident energies 3.3 and 3.7 Mev, respectively. The differential cross section and the polarization are calculated in two limiting cases: zero compound elastic scattering and maximum compound elastic scattering. The theoretical angular distributions and the polarization for scattering in lead are compared with experimental results. As to the polarization for scattering in molybdenum no such comparison is made, because experimental results are not yet available. (auth)

15223 PROTON ANGULAR DISTRIBUTIONS FROM $O^{18}(d,p)O^{19}$ AT $E_d = 7.0$ Mev. G. Wickenberg, S. Hjorth, N. G. E. Johansson, and B. Sjoegren (Nobel Inst. of Physics, Stockholm). Arkiv Fysik, 25: 191-201(1964).

The angular distributions of protons corresponding to the 0-, 0.096-, 1.47-, and 2.35-Mev O^{19} states from the reaction $O^{18}(d,p)O^{19}$ and of elastically scattered deuterons by O^{18} were measured at a bombarding energy of 7 Mev. DWBA analyses of the distributions were performed, and some results from these calculations are shown. For the (d,p) transitions to the ground state and 1.47-Mev state, the spectroscopic factors agree well with those obtained from PWBA analyses as well as with those previously measured at 15-Mev deuteron energy. The proton angular distributions corresponding to the 0.096- and 2.35-Mev states in O^{19} could not be well fitted with stripping predictions. (auth)

15224 LEVELS IN Tb^{159} POPULATED IN THE DECAY OF Gd^{159}. Lars Persson (Nobel Inst. of Physics, Stockholm and Universität, Copenhagen). Arkiv Fysik, 25: 307-16(1964).

The beta decay of 18-hr Gd^{159} was investigated with magnetic beta-ray spectrometers and by scintillation spectroscopy. The Gd^{159} source was produced by neutron irradiation of gadolinium enriched in the isotope Gd^{158} to 97.6%. The internal conversion and gamma ray scintillation measurements were performed with a source produced by isotope separation after the activation. The gamma ray spectrum was also studied by the external conversion method. Gamma rays having the energies 348.0 ± 0.4, 536 ± 2, 557 ± 2, 580 ± 1, and 616 ± 2 kev were observed in this decay. The relative intensities of these gamma rays were obtained from the photoelectron lines after correction for the angular dependence of the photoelectric process. In addition to the levels at 58.0, 137.5, and 363.2 kev previously known to be populated in the decay of Gd^{159}, levels in Tb^{159} at 348.0, 580, 616, and 674 kev are suggested to be fed in this beta decay. M1 character is suggested for the 348-kev gamma ray from measured K conversion coefficient. The upper limit found for the K conversion coefficient of the 305-kev transition indicates E1 multipolarity. The log ft value obtained for the beta ray to the 348-kev level indicates a hindered, first forbidden transition in agreement with the $3/2^-$ [521] assignment for the ground state of Gd^{159} and the $5/2^+$ [413] classification of the 348-kev level. The log ft values found for the beta decay to the 580-, 616-, and 674-kev levels are in agreement with the $1/2^+$, $3/2^+$, and $5/2^+$ assignments previously suggested from recently performed Coulomb excitation experiments on Tb^{159}. The possibility of γ-vibrational character of these levels is discussed. (auth)

15225 DECAY OF THE 1.26-MIN ISOMERIC LEVEL IN Dy^{165}. Rune Hardell, Sven Malmskog, and Lars Persson (Chalmers Tekniska Hogskola, Goteborg; Aktiebolaget Atomenergi, Stockholm; and Nobel Inst. of Physics, Stockholm). Arkiv Fysik, 25: 333-41(1964).

The decay of the isomeric level at 108.2 kev in Dy^{165} was investigated with scintillation spectrometers, including the use of the coincidence technique. The half life of the isomeric level was found to be 1.257 ± 0.006 min. The relative intensities of the transitions to the ground state of Dy^{165} and to the 362- and 514-kev levels in Ho^{165} were deduced to be 97.5 ± 0.4, 0.4 ± 0.1, and 2.1 ± 0.3 per cent, respectively, in good agreement with the results of previous measurements. For the 108.2-kev transition, the K conversion coefficient was determined as 3.4 ± 0.2 and $K/(L + M + \ldots)$ as 0.13 ± 0.01. The half life of the 514-kev state in Ho^{165} was found to be less than 10^{-9} sec. Two weak gamma rays having the energies 655 ± 10 and

755 ± 15 kev were observed to decay in accordance with the 1.26-min half life. Levels at 1017 ± 10 and 1117 ± 15 kev are tentatively suggested to be populated in the decay of the 108.2-kev isomeric level. The spin and parity assignments of the assumed states are discussed. An unresolved gamma ray distribution with its end-point at about 1100 kev, decaying with a 32.3 ± 0.9 sec half life, was observed. This distribution is tentatively suggested to be associated with the de-excitation of an isomeric level with high spin in Dy^{165} decaying to the ground state rotational band. (auth)

15226 CONTRIBUTION TO THE INVESTIGATION OF Tm^{166} DECAY SCHEME. Z. Preibisz, K. Pawlak, and K. Stryczniewicz (Inst. for Nuclear Research, Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 11: 691-9(1963).

The parity of Er^{166} levels at 2137.3 and 2164.6 kev following the decay of Tm^{166} and the multipolarity of gamma transitions from these levels to the first excited state at 80.6 kev (2^+) were investigated. (R.E.U.)

15227 THE $Sr^{88}(d,p)Sr^{89}$ REACTION. R. L. Preston, M. B. Sampson, and H. J. Martin (Indiana Univ., Bloomington, Ind.). Can. J. Phys., 42: 321-8(Feb. 1964).

Thirteen energy levels in Sr^{89} were excited by the $Sr^{88}(d,p)Sr^{89}$ reaction. The excitation energies of the levels are 0, 1.04, 2.00, 2.44, 2.67, 3.18, 3.45, 3.74, 4.10, 4.44, 4.60, 4.97, and 5.38 Mev. The ground-state Q-value is 4.15 ± 0.04 Mev. Angular distributions were measured for protons leaving Sr^{89} in the first three levels and for the 3.74-Mev state. Spin assignments were made using the shell model and the DWBA stripping theory. The assignments are $2d_{5/2}$ for the ground state, $3s_{1/2}$ for the 1.04-Mev state, $2d_{3/2}$ for the 2.00-Mev state, and $J = 1/2$ for the 3.74-Mev state. The results are compared with analogous data on Zr^{91} levels. (auth)

15228 SOME NEW MASS COMPARISONS INVOLVING ISOTOPES OF Ti, V, Zn, Ge, AND Se. R. C. Barber, W. McLatchie, R. L. Bishop, J. D. MacDougall, P. van Rookhuyzen, and H. E. Duckworth (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 42: 391-4(Feb. 1964).

Spectrometric data are presented for the doublets $Ti^{46}Cl^{35}Cl^{37} - Ti^{48}Cl_2^{35}$, $Ti^{47}Cl^{35}Cl^{37} - Ti^{49}Cl_2^{35}$, $Ti^{47}Cl_2^{37} - V^{51}Cl_2^{35}$, $Ti^{49}Cl^{37} - V^{51}Cl^{35}$, $Zn^{68}Cl^{35} - Zn^{66}Cl^{37}$, $Zn^{70}Cl^{35} - Zn^{68}Cl^{37}$, $Ge^{74}Cl^{35} - Ge^{72}Cl^{37}$, $Ge^{76}Cl^{35} - Ge^{74}Cl^{37}$, and $Se^{80}Cl^{35} - Se^{78}Cl^{37}$. (R.E.U.)

15229 NEW 5− AND 6+ STATES IN Ne^{20}. J. A. Kuehner and J. D. Pearson (Chalk River Nuclear Labs., Chalk River, Ont.). Can. J. Phys., 42: 477-88(Mar. 1964). (AECL-1884)

Excited states of Ne^{20} at excitation energies of 8.46 Mev and 8.79 Mev were identified and assigned spin and parity values of 5− and 6+, respectively. The excited states were produced in the $C^{12}(C^{12}, \alpha)Ne^{20}$ reaction and the spin assignments were made on the basis of angular correlations of the decay alpha particles from these states leaving O^{16} in its ground state. It is postulated that the 5− state is the fourth member of a K = 2 negative-parity rotational band based on the 2− 4.97-Mev state and that the 6+ state is the fourth member of a K = 0 rotational band based on the 0+ ground state of Ne^{20}. (auth)

15230 LEVELS IN Ne^{20} FROM THE $C^{12}(C^{12}, \alpha)Ne^{20}$ REACTION. J. D. Pearson, E. Almqvist, and J. A. Kuehner (Chalk River Nuclear Labs., Chalk River, Ont.). Can. J. Phys., 42: 489-93(Mar. 1964). (AECL-1883)

A high-resolution magnetic spectrometer, which compensates for $dE/d\theta$ effects, was used to examine levels in Ne^{20} produced in the $C^{12}(C^{12}, \alpha)Ne^{20}$ reaction, using the C^{12} beam from the Chalk River tandem accelerator. Levels were observed at excitations (Mev) of 4.25, 4.97, 5.62, 5.79, 6.71, 7.02, 7.17, 7.21, 7.43, 7.85, 8.46, 8.71, 8.79, 8.87, 9.04, 9.11, (9.31), 9.48, and 10.24 all with an estimated error of ± 0.02 Mev. (auth)

15231 THE BETA DECAY OF Cs^{134}. W. Van Wijngaarden and R. D. Connor (Univ. of Manitoba, Winnipeg, Can.). Can. J. Phys., 42: 504-18(Mar. 1964).

Magnetic spectrometer studies reveal that the β decay of Cs^{134} proceeds via three partial spectra whose end-point energies, intensities, and $\log_{10}ft$ values are as follows:

Energy (kev)	Intensity (%)	$\log_{10}ft$
662	71	8.8
410	1	10.0
89	28	6.4

No evidence is found for β transitions of intermediate energies. Upper limits have been placed on two previously reported β transitions of higher energy. (auth)

15232 CALCULATION OF THE ABSORPTION RATES OF π^- MESONS BY NUCLEI. Magda Ericson (Université, Lyon). Compt. Rend., 258: 1471-4(Feb. 3, 1964). (In French)

The probabilities for the absorption of π mesons in mesic atoms was calculated by assuming an absorption by nucleon pairs and by using the production amplitudes of π mesons. The corresponding imaginary optical potential was constructed. Experimental results are in good agreement with the hypothesis of pair absorption. (tr-auth)

15233 HALF-LIFE OF THE 123.6-kev LEVEL OF LUTETIUM-173. Nils Perrin (Faculté des Sciences, Orsay, France). Compt. Rend., 258: 1475-7(Feb. 3, 1964). (In French)

The half life of the 123.6-kev level of Lu^{173} was measured using a NaI(Tl) crystal. The electronic apparatus for the measurement is described. A value of 77 ± 5 μsec was found for the half life. The conversion coefficient was calculated to be 0.145 ± 0.02, which assures the E1 character of the transition. If the M2 mixture exists, it is less than 2%. (J.S.R.)

15234 NEUTRON CROSS SECTION OF CHROMIUM FROM 500 TO 1200 kev. Jean Cabe, Michel Laurat, and Pierre Yvon. Compt. Rend., 258: 1478-80(Feb. 3, 1964). (In French)

Use of the 2-Mev Van de Graaff beam permitted a measurement of the total cross section of Cr for neutrons from 500 to 1200 kev. The curve has numerous levels of which three are particularly well separated near 755-, 873-, and 902-kev. The Breit-Wigner formula, applied to experimental results, gives $J = 3/2$ for the first and third levels (by taking into account the fact that the sample contains only 84% Cr^{52}) and $J = 1/2$ for the second. (tr-auth)

15235 NUCLEAR TEMPERATURES OF HIGHLY EXCITED NUCLEI IN THE REGION OF THE MAGIC NUCLEON NUMBERS Z = 50 AND N = 82. R. Plattner, P. Huber, C. Poppelbaum, and R. Wagner (Universität, Basel). Helv. Phys. Acta, 36: 1059-72(1963). (In German)

For a number of elements, the energy spectra N(E) dE resulting from inelastic scattering of a 14-Mev incident neutron beam were measured with a time-of-flight spectrometer. The LeCouteur formula was used to infer a nuclear temperature T of the residual nucleus: $N(E)\,dE = \text{const.}\ E^{3/2} \exp(-12\,E/11\,T)\,dE$. The measured elements

and their temperatures in Mev are: Mo (0.90), Ag(0.97), Cd (0.85), Sn (0.83), Sb (0.89), Te (0.96), I (0.89), Ba (1.01), Ce (0.90), Hg (0.98), Pb^{206} (1.11), Pb (1.28), and Bi (1.26). From these results the level density coefficients $a = E^*_{eff}/T^2$ were calculated, where $E^*_{eff} = E_0 - 2T + P(Z) + P(N)$ and the P's are Cameron's values for the pairing energy. The values of a were compared with the theoretical work of Newton and Rosenzweig. They showed the decrease of level density near the magic neutron numbers 82 and 126 predicted by Newton. No such effect was found near the magic proton number 50. (auth)

15236 END-POINT ENERGIES OF Y^{90}, P^{32}, RaE AND Tl^{204}. B. Somalinga Sastry and Swami Jnanananda (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 2: 66 (1964).

Using the exponential absorption property of beta radiation in a heavy material (gold) and the scintillation technique, the end-point energies of the isotopes Y^{90}, P^{32}, Bi^{210}, and Tl^{204} were computed from the corresponding measured mass absorption coefficients. The results show that when fast counting is required, the scintillation counter can be used as an alternative to the Geiger-Mueller counter in the absorption method of measurement of end-point energies. (auth)

15237 GAMMA RAY SPECTRUM OF A Po–Be NEUTRON SOURCE. D. L. Sastry, B. S. Sastry, and Swami Jnanananda (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 2: 66-8(1964).

The gamma-ray spectrum of a 4-curie Po–Be neutron source was studied employing a single crystal scintillation spectrometer. Besides the 4.42-Mev intense gamma component, a weak 3.02-Mev gamma component was recorded providing further evidence for the emission by a Po–Be source of a component of approximately the same energy. (auth)

15238 HALF-LIFE OF ^{209}Bi. J. Halperin, C. R. Baldock, R. E. Druschel, J. H. Oliver, and R. W. Stoughton (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 26: 391-3(Mar. 1964).

A value for the half life of Bi^{209} was determined to be 3.68×10^5 years with a standard error of 1% from measurements of the specific activity of the 2.615 Mev γ ray and isotopic composition of samples of neutron irradiated bismuth. (auth)

15239 A REDETERMINATION OF THE HALF-LIFE OF URANIUM-232. J. M. Chilton, R. A. Gilbert, R. E. Leuze, and W. S. Lyon (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 26: 395-9(Mar. 1964).

A value of 71.4 ± 0.6 years was determined for the half life of U^{232} by measuring the heat evolution of a weighed sample of uranium oxide whose uranium content was 99.24% mass 232. A value of 72.1 ± 0.5 years was obtained by counting the alpha disintegration rate. A mean between these values, 71.7 ± 0.9 years, at an estimated 95% confidence level is proposed for the half life of U^{232}. (auth)

15240 SPONTANEOUS AND 14.7 Mev NEUTRON-INDUCED FISSION YIELDS OF URANIUM-238 IN THE RARE EARTH REGION. M. P. Menon and P. K. Kuroda (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem., 26: 401-8(Mar. 1964).

Levels of fission product activities in secular equilibrium with U^{238} in nonirradiated uranium salts give the general shape of the mass-yield curve for U^{238} spontaneous fission. The equilibrium ratios were measured for a number of fission products in the rare earth region. The results expressed in terms of 10^{-4} disintegrations sec^{-1} g^{-1} of U^{238} are: Ce^{141}, 4.9 ± 1.0; Ce^{143}, 4.4 ± 0.8; Ce^{144}, 4 ± 1; Nd^{147}, 3.1 ± 0.8; Pm^{147}, 3.6 ± 0.9; Pm^{149}, 1.6 ± 0.2. A comparative study was made of the rare earth region of the mass-yield curve for 14.7 Mev neutron-induced fission of U^{238}. (auth)

15241 OSCILLATOR STRENGTHS, TRANSITION PROBABILITIES AND THE LIFETIME OF THE EXCITED STATES FOR THE HELIUM AND LITHIUM LIKE ATOMS. A. Kancerevicius (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR). Leituvos Fiz. Rinkinys, 2: 245-57(1962). (In Russian)

Three alternative expressions for the dipole moment used in calculations of oscillator strengths and transition probabilities are discussed. With the help of analytic wave functions oscillator strengths, transition probabilities, and the lifetime of the corresponding upper states for the transitions $n_1p - n's$ and $n_2d - 2p$ ($n_1 = 2, 3, 4, 5$; $n' = 1, 2$; $n_2 = 3, 4, 5$) in helium and lithium like atoms are calculated. The oscillator strengths for transitions $nl - n'l \pm 1$ ($n = 3, 4$; $l = 2, 3$; $n' = 5, 6, \ldots 15$) using hydrogenic wave functions are calculated. (auth)

15242 EXCITATION OF THE LOW LEVELS OF Li^7, Be^8, Be^9, AND Be^{10} IN THE ALPHA-PARTICLE BOMBARDMENT OF LITHIUM. K. V. Makariunas, E. K. Makariuniene, and V. J. Dienys (Inst. of Physics and Mathematics. Academy of Sciences, Lithuanian SSR). Leituvos Fiz. Rinkinys, 2: 351-61(1962). (In Russian)

The range spectra in the photographic plates of the particles from the reactions (α,α^1), (α,t), (α,d), and (α,p) on lithium nuclei were investigated for the bombarding alpha-particle energy $E_\alpha = 13.2$ and 14.7 Mev. Typical examples of spectra are shown. The reactions and the levels observed are listed. The angular distribution of the reaction $Li^7(\alpha,\alpha^1)Li^{7*}$ ($Q = -6.5$ Mev) was investigated in the forward angle region for $E\alpha = 13.2$ Mev and also the angular distributions of the reactions $Li^7(\alpha,t^1)Be^{8*}$ ($Q = -5.46$ Mev) and $Li^7(\alpha,p^1)Be^{10*}$ ($Q = -5.928$ Mev) for $E\alpha = 14.7$ Mev. All angular distributions show the strong anisotropy and have maxima at small forward angles. There are indications of the direct interaction mechanism in these reactions. From an interpretation of the experimental angular distribution of the reaction (α,α^1) within the framework of Butler's theory it follows that the parity of the 6.5 Mev level in Li^7 nucleus is even and the spin is equal to one of the following three values: $^1/_2$, $^3/_2$, and $^5/_2$. The experimental angular distribution of the reaction (α,t^1) can be described in the framework of the Butler type alpha-particle stripping theory with the two values of the parameter l: 1 and 3. (auth)

15243 DYSPROSIUM RESONANCE INTEGRALS. J. J. Scoville, E. Fast, and D. W. Knight (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Sci. Eng., 18: 400(Mar. 1964).

A revised value for the infinitely dilute absorption resonance integral of natural dysprosium is given; experimental values for the separate isotopes are also given. Revision of NSA, 17: 3780. (R.E.U.)

15244 A NOTE ON THE SPALLATION OF SILVER AND BROMINE BY HIGH-ENERGY PROTONS AND HEAVY NUCLEI. C. J. Waddington (Univ. of Minnesota, Minn.). Nuovo Cimento (10), 31: 748-55(Feb. 16, 1964).

It is shown that the prong-number distribution of stars produced in nuclear emulsions by energetic protons may be used to give a qualitative indication of the spallation element yield curve for silver and bromine target nuclei. The prong number distribution of stars produced by energetic, $E \geq 1.5$ Bev per nucleon, cosmic-ray nuclei with $Z \geq 6$ is examined in a similar manner and it is shown that the spallation yield curve on the same target nuclei is significantly different from that observed for protons. (auth)

15245 MEASUREMENT OF THE g-FACTOR OF THE 412 kev STATE IN Hg^{198}. L. Keszthelyi, I. Berkes, I. Dézsi, B. Molnár, and L. Pócs (Central Research Inst. of Physics, Budapest). Phys. Letters, 8: 195-6(Feb. 1, 1964).

The precession in the internal field of the angular correlation pattern of the 675 kev–412 kev cascade of Hg^{198} following β-decay of Au^{198} was measured to determine the g-factor of the 412-kev state. g was found to be +0.38 ± 0.08. (R.E.U.)

15246 EXCITATION OF LOW EXCITED STATES IN Cd^{114} BY (p,p') REACTION. M. Sakai (Tokyo Univ.), H. Ikegami, Y. Nakagima, K. Yagi, H. Ejiri, and G. R. Satchler. Phys. Letters, 8: 197-200(Feb. 1, 1964).

Proton inelastic scattering at 12.16 Mev was used to study the excitation of levels in Cd^{114}. 19 references. (R.E.U.)

15247 ALPHA-DECAY PROPERTIES OF SOME FRANCIUM ISOTOPES NEAR THE 126-NEUTRON CLOSED SHELL. Roger D. Griffioen and Ronald D. MacFarlane (Univ. of California, Berkeley). Phys. Rev., 133: B1373-80(Mar. 23, 1964). (UCRL-10930)

Several new alpha-emitting isotopes of francium were produced by the reactions $Au^{197}(O^{16},xn)Fr^{213-x}$, $Tl^{203}(C^{12},xn) \times Fr^{215-x}$, $Tl^{205}(C^{12},xn)Fr^{217-x}$, and $Pb^{208}(B^{11},xn)Fr^{219-x}$. The nuclide studies lie on or below the 126-neutron closed shell. Their alpha-decay properties are as follows:

Nuclide	Q_α (Mev)	Half life (sec)
Fr^{213}	6.90 ± 0.01	33.7 ± 1.5
Fr^{211}	6.68 ± 0.02	186 ± 4.0
Fr^{210}	6.68 ± 0.02	159 ± 5.0
Fr^{209}	6.78 ± 0.02	54.7 ± 1.0
Fr^{208}	6.78 ± 0.02	37.5 ± 2.0
Fr^{207}	6.90 ± 0.02	18.7 ± 0.8
Fr^{206}	6.92 ± 0.02	15.8 ± 0.4
Fr^{205}	7.05 ± 0.02	3.7 ± 0.4
Fr^{204}	7.16 ± 0.03	2.0 ± 0.5

Alpha-decay reduced widths δ^2 were calculated by using beta-decay systematics from this region to estimate the beta branching ratios. These reduced widths are compared to those of the isotonic polonium isotopes. (auth)

15248 E2/M1 RATIOS IN THE ISOMERIC TRANSITIONS OF Te^{121} AND Te^{123}, AND THE DECAY OF THE Te^{121} ISOMERS TO Sb^{121}. Y. Y. Chu, O. C. Kistner, A. C. Li, S. Monaro, and M. L. Perlman (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 133: B1361-7(Mar. 23, 1964). (BNL-7467)

The decay of Te^{121} isomers and the decay of Te^{123m} were investigated with scintillation and proportional counter spectrometers, coincidence techniques, and a high resolution beta-ray spectrometer for the measurement of the conversion spectrum. In the decay of the Te^{121} isomers to levels of Sb^{121}, transitions of the following energies were found: 37, 66, 470, 508, 573, and 1110 kev. The 37, 1110, and 66,508 cascades were established by coincidence measurements. A 37, 470 cascade is indicated by precision energy measurements. Coincidences between the 66- and 1110-kev transitions expected to occur could not be found. By a careful analysis of the conversion spectrum, it was possible to determine, from L subshell ratios, the multipolarities of most of the gamma rays. A decay scheme is proposed that accounts for all of the observed data and in which the first-excited state in Sb^{121} lies at 37 kev. The half life of the 37-kev level in Sb^{121}, measured by the delayed coincidence method, was found to be (3.5 ± 0.2) × 10^{-9} sec. From the analysis of the $L_1/L_2/L_3$ ratios observed in the conversion spectrum, the E2/M1 ratio values could be determined for the 212- and 159-kev transitions in Te^{121m} and Te^{123m}, respectively. The results are: E2/M1 = 0.050 for the 212-kev transition and E2/M1 = 0.0067 for the 159-kev transition. The E2 speeds of these transitions were inferred from the known lifetimes of the 212-kev state in Te^{121} and of the 159-kev state in Te^{123}; the results are 26 and 4.5 times the single-particle speeds, respectively. (auth)

15249 INTERNAL PAIR EMISSION FROM ALIGNED NUCLEI. E. K. Warburton (Oxford Univ.). Phys. Rev., 133: B1368-72(Mar. 23, 1964).

The general correlation function describing the emission of positron-electron pairs from aligned nuclei is obtained from a plane-wave calculation. Results are presented and discussed for pure magnetic and pure electric transitions and for mixed transitions. It is assumed that the emitting state, although aligned, is unpolarized and that the polarization of neither member of the pair is observed. The dependence of internal pair emission on the nuclear alignment is compared with that of the competing gamma radiation. The behavior of the correlation function in the high-energy limit is also discussed. (auth)

15250 TWO-NUCLEON INTERACTION IN A COMMON HARMONIC OSCILLATOR POTENTIAL. B. P. Nigam (Univ. of Buffalo). Phys. Rev., 133: B1381-7(Mar. 23, 1964).

The problem of two nucleons moving in a common harmonic oscillator potential modified by the effective two-nucleon potential is considered. The two-nucleon potential includes hard core, central, spin-orbit, and tensor parts. It is found that the appropriate Green's function is factorable and hence the solution of the relevant Schrödinger equation can be expressed as an expansion in terms of the harmonic oscillator wave functions whose radial arguments are shifted by an amount equal to the radius of the repulsive core. Numerical estimates were made for O^{17}. It turns out that for moderate strength of the effective two-nucleon potential the expansion coefficients become vanishingly small after the first few terms so that the procedure seems to be rapidly convergent. (auth)

15251 EFFECT OF PAIRING CORRELATIONS ON NUCLEAR GAMMA-RAY TRANSITIONS. Hidetsugu Ikegami (Brookhaven National Lab., Upton, N. Y.) and Takeshi Udagawa. Phys. Rev., 133: B1388-1400(Mar. 23, 1964). (BNL-7446)

Several examples of the effect of pairing correlations on nuclear gamma-ray transitions are presented. It is shown that even if collective coupling exists, gamma-ray transitions of electric multipole type between low-lying quasiparticle states whose free shell-model orbit energies are symmetrically related to the Fermi energy may be extremely retarded. The factor $(U_iU_f - V_iV_f)$ that arises from the pairing correlation is directly estimated from empirical even-odd mass difference data. The agreement of the calculated transition probabilities with experimental results is good. A shell-model calculation taking into account the pairing correlation was also made for transitions of E2 type between $d_{\frac{5}{2}}$ and $s_{\frac{1}{2}}$ orbits in Sn^{117} and Sn^{118} and the results are compared with that of the quasiparticle approximation. It is shown that the quasiparticle approximation is more improved by using renormalized wave functions that are obtained by projecting out only the terms having the correct number of particles than by taking into account only the blocking effect except for special cases. (auth)

15252 CALCULATION OF SOME FOURTH-ORDER DIAGRAMS IN NUCLEAR MATTER. A. G. Petschek (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 133: B1401-3(Mar. 23, 1964). (LADC-5987)

It is well known that in the Goldstone theory of many-fermion systems certain higher-order diagrams are included in the third-order diagrams if the hole self-energy is evaluated on the energy shell. A similar generalization of fourth-order diagrams is carried out. With this generalization, the Hartree-Fock potential U, which cancels the third-order diagrams, no longer cancels the fourth-order diagrams as well as before. The lack of cancellation is evaluated in two simple cases using the reference approximation, and found to be large in one case, small in the other. (auth)

15253 AVERAGE NUMBER OF PROMPT NEUTRONS FROM U^{235} FISSION INDUCED BY NEUTRONS FROM THERMAL TO 8 Mev. D. S. Mather, P. Fieldhouse, and A. Moat (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Phys. Rev., 133: B1403-20(Mar. 23, 1964).

A large, loaded-liquid scintillation counter was used to measure the average number, $\bar{\nu}$, of neutrons emitted in the neutron-induced fission of U^{235} as a function of the incident energy. Time-of-flight techniques were employed where necessary to select fissions induced by neutrons of the desired energy. Values at nineteen energies in the range thermal to 8 Mev were determined; absolute values are based on $\bar{\nu}$ (Cf^{252}, spontaneous) = 3.782 ± 0.024, relative errors are about 1%. The variation of $\bar{\nu}$ with energy cannot be represented by a single straight line. A satisfactory fit to the experimental points is given either by the relationship $\bar{\nu}(E) = (2.423 \pm 0.008) + (0.088 \pm 0.008)E + (0.0088 \pm 0.0011)E^2$, or by two straight lines; $\bar{\nu}(E) = (2.418 \pm 0.008) + (0.109 \pm 0.006)E$ from 0 to 3 Mev, and $\bar{\nu}(E) = (2.200 \pm 0.023) + (0.181 \pm 0.005)E$ from 3 to 8 Mev. (auth)

15254 ELASTIC SCATTERING OF ALPHA PARTICLES BY C^{12} IN THE BOMBARDING ENERGY RANGE 10 to 19 Mev. E. B. Carter, G. E. Mitchell, and R. H. Davis (Florida State Univ., Tallahassee). Phys. Rev., 133: B1421-33(Mar. 23, 1964).

The scattering of alpha particles by C^{12} was studied in the bombarding energy range 10 to 19 Mev. Many anomalies were observed in the excitation curves that correspond to O^{16} compound system energy levels in the excitation energy range 14 to 21 Mev. Fifteen detailed angular distributions were measured and the data were analyzed with a smooth cutoff model, which was modified to include appropriate resonant phase shifts. The spins and parities of the more prominent resonances were assigned. Real well depths of 100 Mev or more were required in an optical-model analysis to yield theoretical cross sections comparable with experimental values. In general, optical-model fits were not satisfactory. Two series of levels in O^{16} were observed which obey rotational band systematics. The substantial widths of the band members suggest an alpha-particle cluster configuration for these excited states. (auth)

15255 INELASTIC SCATTERING OF 6- TO 19-Mev ALPHA PARTICLES FROM CARBON. G. E. Mitchell, E. B. Carter, and R. H. Davis (Florida State Univ., Tallahassee). Phys. Rev., 133: B1434-45(Mar. 23, 1964).

The inelastic scattering of alpha particles from C^{12} was studied in detail. The 4.43-Mev gamma rays were observed from 6- to 17-Mev bombarding energy; the particles were observed from 10 to 19 Mev. Analysis of the gamma-ray data yielded the following specific conclusions: (1) Near 13.1-Mev excitation energy in O^{16} there is apparently a 2^+ level in addition to the well known 1^- level. (2) The 13.27-Mev level is 3^-, as previously reported. (3) The previously unassigned state at 13.88 Mev is 4^+. (4) A previously unreported level at 14.80 Mev has a low spin value. Numerous additional levels were found. The "two-channel" coupled equations approximation predicts many of the qualitative features of the particle angular distributions. Since the coupling is very strong, calculations for C^{12} illustrate well some of the features of this approximation. (auth)

15256 DOUBLE STRIPPING: (He^3,n) REACTION. Ernest M. Henley and David U. L. Yu (Univ. of Washington, Seattle). Phys. Rev., 133: B1445-70(Mar. 23, 1964).

The two-nucleon stripping reaction is examined in detail, with particular reference to the (He^3,n) reaction. Three models are studied and compared: (1) the plane-wave Born approximation, (2) the distorted-wave Born approximation, and (3) a simple diffraction model. Zero-range approximations are not assumed a priori. For (1) and (2), the wave functions of the two captured nucleons are taken to be eigenstates of an infinite harmonic oscillator, the strength of which is adjusted to reproduce single-particle eigenfunctions of a finite Saxon well in regions close to the nuclear surface. The first model is primarily employed to show that the modulation of the angular distribution due to the structure of He^3 is also sensitive to the form and range of the stripping interaction. Model (2) is used to calculate absolute differential cross sections to various final states, in particular for C^{12}, O^{16}, Ni, and Sn targets with 20-Mev incident He^3 ions. Comparison with experimental data is made where available, and agreement is found. To further such comparisons we also compute summed cross sections to several low-lying states of the final nucleus. Spectroscopic weights are obtained for pure and mixed configurations of single-particle wave functions. Model (3) provides insight into the dominant features of the experimental and calculated [model (2)] differential cross sections. These are: (a) a strong forward peaking of the distribution especially for spin 0 to 0 transitions, but also for summed cross sections, (b) an angular distribution for such sums that is roughly independent of the atomic weight of the target nucleus, and (c) an enhancement of cross sections to higher spin states (≈3 or 4) of final nuclei. These features are not reproduced with model (1). (auth)

15257 FISSION AND REACTION CROSS SECTIONS IN THE URANIUM REGION WITH 4- TO 12-Mev PROTONS. George L. Bate and J. R. Huizenga (Argonne National Lab., Ill.). Phys. Rev., 133: B1471-6(Mar. 23, 1964).

Fission fragment angular distributions were measured with gold surface barrier detectors for proton-induced fission of U^{233}, U^{234}, U^{235}, U^{236}, U^{238}, Np^{237}, and Pu^{239}. Absolute fission cross sections were determined for U^{233} and U^{238}. The proton projectile energy range of 4 to 12 Mev was obtained with the Argonne tandem Van de Graaff. Over this energy range the fission cross section of U^{233} changed by a factor exceeding a million. Total reaction cross sections were calculated for the highly fissionable U^{233} target by applying small corrections (3 to 20%) for the spallation cross sections. These reaction cross sections are compared with theoretical values deduced from surface absorption optical-model calculations with parameters of Perey and Wilkins. (auth)

15258 INELASTIC SCATTERING OF NEUTRONS BY TRITONS. J. L. Gammel and A. D. MacKellar (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 133: B1476-82 (Mar. 23, 1964).

Assuming that the range of nuclear forces is small com-

pared to the size of the triton and the wavelength of the incoming neutron ("zero-range" approximation), a connection is derived between the cross sections for elastic and inelastic n-t scattering by calculating the ratio of the first Born approximation for inelastic to that for elastic scattering. A calculation of the inelastic scattering cross section is made for an incoming neutron energy of 14 Mev. Since experimental elastic angular distributions are not available, values calculated by Bransden and Robertson for p–He^3 assuming Serber interaction are used. Inelastic angular distributions are calculated for the ejected deuteron, the ejected neutron, and the scattered neutron. Integrating over the distribution of the ejected deuteron, a value for the total n-t inelastic cross section of 343 mb is obtained. (auth)

15259 NUCLEUS-NUCLEUS REARRANGEMENT SCATTERING. [PART] I. K. R. Greider (Yale Univ., New Haven). Phys. Rev., 133: B1483-94(Mar. 23, 1964). (TID-19635)

Direct-interaction techniques are applied to nucleus-nucleus rearrangement processes in which a nucleon is transferred from one nucleus to the other during the scattering. A formal expression is derived for the transition amplitude assuming a reaction mechanism different from that usually employed in direct-interaction rearrangement processes (such as deuteron stripping). The mechanism in the usual theories is due to the potential between the transferred particle and one of the nuclear "core" systems; the interaction between the two nuclear cores is considered responsible in first order for the rearrangement scattering. Physical arguments support this view for the nucleus-nucleus scattering mechanism and are based on the overwhelming importance of the Coulomb interaction in low-energy processes. The amplitude for the rearrangement scattering is then expressed formally in terms of the complete amplitude or T matrix for the dominant core-core interaction. The specific example of the neutron transfer process is considered in a first-order treatment, where all purely nuclear-scattering interactions are ignored, and the only scattering arises from the Coulomb potential. The matrix element for the reaction is obtained in closed form and the results are compared both with experiment and with other treatments of rearrangement scattering. (auth)

15260 FRAGMENT MASS DISTRIBUTIONS FOR THERMAL-NEUTRON-INDUCED FISSION OF Pu^{239} AND Pu^{241}. F. J. Walter, H. W. Schmitt, and J. H. Neiler (Oak Ridge National Lab., Tenn.). Phys. Rev., 133: B1500-2 (Mar. 23, 1964).

The fragment mass distributions for thermal-neutron-induced fission of Pu^{239} and Pu^{241} were determined from correlated energy measurements of fragment pairs. These mass distributions are compared with each other and with the post-neutron-emission mass yield for Pu^{239} obtained from radiochemical and mass spectrometric measurements. It is shown that these comparisons are consistent with the saw-tooth character of the function $\nu(M)$ as well as with the cluster model of fission in which the stability of the closed-shell structures fundamentally influences the fragment mass and energy distribution for fission at low-excitation energy. (auth)

15261 Q VALUES FOR $B^{10}(He^3,n)N^{12}$ AND N^{12*}. R. W. Kavanagh (California Inst. of Tech., Pasadena). Phys. Rev., 133: B1504-6(Mar. 23, 1964).

Using the reaction $Si^{28}(n,\alpha)Mg^{25}$ in a surface-barrier detector as a neutron spectrometer, a comparison measurement is made of the energies of neutron groups from the reaction $B^{10}(He^3,n)N^{12}$ with $B^{10}(\alpha,n)N^{13}$ as a calibration standard. A ground-state Q value, $Q_0 = 1.561 \pm 0.009$ Mev, is found for $B^{10}(He^3,n)N^{12}$, and two states of N^{12} are located at excitation energies 0.994 ± 0.020 and 1.22 ± 0.03 Mev. (auth)

15262 Q VALUE FOR THE $B^{10}(He^3,N^{12})n$ REACTION BY MAGNETIC ANALYSIS. T. R. Fisher and W. Whaling (California Inst. of Tech., Pasadena). Phys. Rev., 133: B1502-4(Mar. 23, 1964).

The Q value for the reaction $B^{10}(He^3,N^{12})n$ was measured by observing the $(N^{12})^{5+}$ recoil ions in a magnetic spectrometer at 10-Mev bombarding energy. Observations at 1.7 and 7.0° laboratory angle yield $Q = 1.570 \pm 0.025$ Mev, based on the ThC′ alpha line at 8.7841 Mev. The N^{12}–C^{12} mass difference computed from this Q value corresponds to an endpoint energy of 16.320 Mev for the N^{12} beta decay and a ft value of $(1.29 \pm 0.02) \times 10^4$. The ratio $ft(N^{12})/ft(B^{12})$ becomes 1.10 ± 0.02. (auth)

15263 $C^{12}(p,pn)C^{11}$ CROSS SECTION AT 1.0 Gev. A. M. Poskanzer, L. P. Remsberg, S. Katcoff, and J. B. Cumming (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 133: B1507-8(Mar. 23, 1964). (BNL-7562)

The cross section of the $C^{12}(p,pn)C^{11}$ reaction was measured at 1.0 Bev because the excitation function was not well known in this energy region. The cross section was found to be 29.0 ± 1.3 mb. (auth)

15264 L FLUORESCENCE YIELDS IN HEAVY ELEMENTS. J. Woods Halley and D. Engelkemeir (Argonne National Lab., Ill.). Phys. Rev., 134: A24-8(Apr. 6, 1964).

L x-ray fluorescence yields for the Ra, Th, U, Pu, and Cm daughters of even-even alpha emitters were measured by three methods. Internal conversion of E2 gammas from the decay of these nuclides produces approximately equal numbers of L_{II} and L_{III} vacancies and practically no L_I vacancies; the yields reported here are, therefore, averages of the L_{II} and L_{III} shell yields. The results are: Ra, 0.480 ± 0.012; Th, 0.488 ± 0.008; U, 0.478 ± 0.009; Pu, 0.549 ± 0.009; and Cm, 0.531 ± 0.010. (auth)

15265 HYPERFINE STRUCTURE SEPARATION AND MAGNETIC MOMENT OF K^{42}. J. M. Khan, N. Braslau, and G. O. Brink (Univ. of California, Berkeley). Phys. Rev., 134: A45-7(Apr. 6, 1964). (UCRL-7498)

The atomic beam flop-in magnetic-resonance method was employed to measure the hyperfine structure separation $\Delta\nu$ and the nuclear magnetic moment μ_I in the $^2S_{\frac{1}{2}}$ electronic ground state of the 12.4-h potassium-42. The results are: $\Delta\nu(K^{42}) = 1258.877(4)$ Mc/sec; $\mu_I(K^{42}) = -1.1395(30)$ nuclear magnetons (diamagnetic correction not included). With these values, estimates of the hyperfine structure anomaly with respect to other potassium isotopes can be made: $^{39}\Delta^{42} = +0.20(25)\%$, $^{40}\Delta^{42} = -0.25(25)\%$, $^{41}\Delta^{42} = +0.42(25)\%$. (auth)

15266 SPIN AND NUCLEAR MOMENTS OF 245-DAY Zn^{65}; REDETERMINATION OF THE HFS OF Zn^{67} AND $\tau(^3P_1)$ OF ZINC. F. W. Byron, Jr., M. N. McDermott, R. Novick, B. W. Perry, and E. B. Saloman (Columbia Univ., New York). Phys. Rev., 134: A47-55(Apr. 6, 1964).

The hfs of the $(4s4p)^3P_1$ state of 245-day Zn^{65} and of Zn^{67} was determined by the optical double-resonance technique. The nuclear spin I, and the hfs splittings are: Zn^{65}: $I = \frac{5}{2}$, $\nu(\frac{7}{2} - \frac{5}{2}) = 1875.475(6)$ Mc/sec, $\nu(\frac{5}{2} - \frac{3}{2}) = 1334.123(6)$ Mc/sec; Zn^{67}: $\nu(\frac{7}{2} - \frac{5}{2}) = 2111.300(3)$ Mc/sec, $\nu(\frac{5}{2} - \frac{3}{2}) = 1551.565(4)$ Mc/sec. The hfs coupling constants, corrected to second order for interaction with the $^3P_2$ and $^3P_0$ states, are Zn^{65} $A(65) = +535.163(2)$ Mc/sec, $B(65) = +2.870(5)$ Mc/sec; Zn^{67}: $A(67) = +609.086(2)$ Mc/sec, $B(67) =$

−18.782(8) Mc/sec. If quadrupole shielding effects are neglected, the corresponding moments of Zn^{65} are: $\mu(65) = +0.7692(2)\mu_N$ and $Q(65) = -0.024(2)$b. The value given for $\mu(65)$ includes an estimated correction of 0.09(8)% for the hfs anomaly. The ratio of the Zn^{65} and Zn^{67} quadrupole moments is $Q(65)/Q(67) = -0.1528(3)$; this result is independent of the shielding corrections. The Zn^{65} spin and magnetic moment are consistent with a $(2p_{\frac{1}{2}})^4(1f_{\frac{5}{2}})^3$ neutron assignment with some configuration mixing. The small quadrupole moment is compatible with the zero moment expected for a half-filled f shell. In the course of this work, the lifetime of the $(4s4p)\ ^3P_1$ state of zinc was redetermined and found to be $\tau(^3P_1) = 20(2)$ μsec. This result includes a large correction for the effects of wall collisions. The theory of wall broadening of optical double-resonance lines is developed. (auth)

15267 LEVEL CROSSING DETERMINATION OF $\tau(^1P_1)$ AND $g_J(^3P_1)$ IN ZINC AND THE HFS OF Zn^{65} AND Zn^{67}. A. Landman and R. Novick (Columbia Univ., New York). Phys. Rev., 134: A56-65(Apr. 6, 1964).

Optical detection of level crossing in the $(4s4p)\ ^3P_1$ state of stable Zn^{67} and of 245-day Zn^{65}, using the intercombination line at 3076 Å, resulted in a precise determination of the ratios of the dipole and quadrupole hyperfine coupling constants in each of the isotopes to the Landé g_J factor of this state. Using these results and the values of the dipole coupling constant for each isotope, as determined from double resonance experiments, the following values for the atomic g factor and "isolated" quadrupole interaction constants were obtained: Zn^{67}: $g_J = 1.501006(8)$ and $B = -18.770(12)$ Mc/sec, Zn^{65}: $g_J = 1.500984(20)$ and $B = 2.867(12)$ Mc/sec. The results for B agree with those obtained from double resonance, indicating the adequacy of the treatment of the second-order fine-structure corrections. The lifetime (τ) of the $(4s4p)\ ^1P_1$ state of Zn was determined to be $\tau = (1.38 \pm 0.05) \times 10^{-9}$ sec through the observation of the zero-field level crossing (Hanle effect), using the resonance line at 2138 Å. These latter experiments were performed with natural zinc (96% even isotopes), and included the quantitative determination of coherence narrowing. (auth)

15268 RELATIONSHIP BETWEEN THE OPTICAL MODEL AND THE RESONANCE THEORY. A. P. Jain (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 134: B1-7(Apr. 13, 1964). (BNL-7198)

The relation between cross sections and the strength function is discussed. The usually used simple linear relation is shown to be an approximation to the more general theory of Wigner and Eisenbud. With this theory, a consistent and simple behavior of the strength function with respect to the energy and the atomic weight can be obtained. The problems of the proper choice of the boundary condition and the matching radius for the diffuse well are discussed. A quantitative estimate of the effect of the nonlinear terms in a typical nucleus Nb^{93} is presented. (auth)

15269 REMARKS ON THE MIXED MULTIPOLE INTERNAL CONVERSION ELECTRON CORRELATION PARAMETERS. L. C. Biedenharn (Duke Univ., Durham, N. C.) and M. E. Rose. Phys. Rev., 134: B8-15(Apr. 13, 1964).

The internal conversion electron correlation parameters are calculated for the general K-shell (mixed) multipole conversion. Phase conventions are critically examined, and the sign of the mixed electric-magnetic conversion proposed by Church, Weneser, and Schwarzschild is verified. Phase conventions for the Dirac-Coulomb continuum wave functions are shown to be ambiguous, and a suitable standard convention is proposed. (auth)

15270 BETA DECAY OF N^{17} TO BOUND STATES IN O^{17}. M. G. Silbert and J. C. Hopkins (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 134: B16-22(Apr. 13, 1964). (LADC-5831)

The beta decay of N^{17} to bound states of O^{17} was investigated by observation of the beta-ray and gamma-ray spectra with scintillation spectrometers. A gas target of N_2^{15} was bombarded with 2-Mev tritons from an electrostatic generator to yield 4.2-sec N^{17} by the reaction $N^{15}(t,p)N^{17}$. Gamma rays of 0.87 and 2.19 Mev were observed, corresponding to beta transitions to the 0.87- and 3.06-Mev levels in O^{17}. Analysis of the beta-ray spectrum indicated the presence of a beta-decay branch to the ground state of O^{17}. The branching fractions and log ft values for these three beta transitions are: O^{17} g.s. −1.6%, log ft = 7.3; 0.87-Mev level −2.6%, log ft = 6.8; and 3.06-Mev level −0.5%, log ft = 6.9. Uncertainties in these log ft values are about ±0.1. The large log ft value for the allowed transition to the 3.06-Mev state lends support to previous theoretical calculations which indicate that this low-lying negative parity state in O^{17} consists of a three-particle excitation of the O^{16} core. (auth)

15271 ALPHA DECAY OF EVEN-EVEN NUCLEI. F. C. Chang (St. John's Univ., Jamaica, N. Y.). Phys. Rev., 134: B23-4(Apr. 13, 1964).

A possible correlation between trends in the hindrance of alpha transitions to members of the ground-state rotational band of even-even nuclei and variations in the availabilities of various states in the nuclear surface is discussed. (auth)

15272 SPIN AND NUCLEAR MOMENTS OF 2.3-DAY Cd^{115} AND OF 43-DAY Cd^{115m}. M. N. McDermott, R. Novick, B. W. Perry, and E. B. Saloman (Columbia Univ., New York). Phys. Rev., 134: B25-9(Apr. 13, 1964).

The Zeeman structure and hfs in the $(5s5p)^3P_1$ state of 2.3-day Cd^{115} and 43-day Cd^{115m} were determined by the optical double-resonance technique. The nuclear spin I, magnetic dipole coupling constant A, and electric quadrupole coupling constant B, are: $I(115) = 1/2$, $A(115) = -4484(2)$ Mc; $I(115m) = 11/2$, $A(115m) = -657.6(6)$ Mc, $B(115m) = +131(6)$ Mc. If nuclear structure and quadrupole shielding effects are neglected, the corresponding nuclear moments are: $\mu(115) = -0.6469(3)\mu_N$, $\mu(115m) = -1.0437(10)\mu_N$, $Q(115m) = -0.61(8)$ b. The ratio of the Cd^{115m} and Cd^{109} quadrupole moments is $Q(115m)/Q(109) = -0.79(3)$; this result is independent of shielding corrections. The Cd^{115} nuclear moment is compared with the moment predicted for a $(3s_{\frac{1}{2}})^1(1h_{\frac{11}{2}})^2$ neutron assignment with configuration mixing. The Cd^{115m} moment is compared with the moments predicted for both a $(3s_{\frac{1}{2}})^0(1h_{\frac{11}{2}})^3$ and a $(3s_{\frac{1}{2}})^2(1h_{\frac{11}{2}})^1$ assignment. Both isomers were produced by (n,γ) reactions on Cd^{114}. The longer-lived isomer, 43-day Cd^{115m}, was separated from the Cd^{114} with an electromagnetic mass separator; about 10^{11} atoms were obtained in the resonance cell. No mass separation was performed on the Cd^{115}, but it was identified from the decay of the resonances over a 6-day period. The half life deduced from the observed decay is $T_{\frac{1}{2}} = 41(7)$ h, as compared with the accepted value of 56 h. (auth)

15273 RECOIL PROPERTIES OF Sm^{142} FROM NUCLEAR REACTIONS INDUCED BY HEAVY IONS. I. SAMARIUM COMPOUND SYSTEMS. Morton Kaplan and Richard D. Fink (Yale Univ., New Haven). Phys. Rev., 134: B30-7(Apr. 13, 1964).

By means of thin-target differential-range experiments, the average ranges and range straggling 72-min Sm^{142} recoils from a number of nuclear reactions induced by heavy ions were measured. Beams of Li^6, Li^7, B^{10}, C^{12}, and N^{14} with kinetic energies up to 10.5 Mev per nucleon were used in conjunction with targets of Cs^{133}, Ba^{136}, Ba^{137}, Ba^{138}, La^{139}, and Pr^{141}. A range-energy curve was obtained for Sm^{142} in Al, covering the region 2- to 10-Mev recoil energy. Strong evidence for a pure compound nucleus reaction mechanism is provided by the uniqueness of the range-energy curve for all the reactions, Gaussian-range distributions, and direct comparison of the experimental ranges with stopping theory. The reaction $Nd^{142}(\alpha,4n)Sm^{142}$ was studied by integral range methods, and the average ranges in Nd were found to be consistent with theoretical expectations when projected ranges were corrected to true ranges. The experimental straggling parameters are compared with theoretical predictions of straggling inherent in the stopping process. For Li^6 and Li^7 experiments, where the recoil velocities are smaller than the Bohr velocity (2.2×10^8 cm/sec), an attempt is made to extract the range straggling due to the nuclear reaction. From this analysis, qualitative information is obtained about the average total energy removed by neutrons and photons. (auth)

15274 RECOIL PROPERTIES OF Sm^{142} FROM NUCLEAR REACTIONS INDUCED BY HEAVY IONS. II. EUROPIUM AND GADOLINIUM COMPOUND SYSTEMS. Morton Kaplan (Yale Univ., New Haven). Phys. Rev., 134: B37-41(Apr. 13, 1964).

Using thin-target recoil techniques, the average ranges and range straggling were measured, in aluminum, of 72-min Sm^{142} produced in heavy-ion induced nuclear reactions. Eight different combinations of target and beam projectile were studied, five leading to Eu compound systems and three leading to Gd compound systems. In all cases the recoil-range distributions could be fitted by Gaussian functions. Comparison of the average ranges with a range-energy curve for Sm^{142} in Al provides evidence for a compound-nucleus mechanism in these reactions. The straggling parameters observed in reactions leading to Eu compound systems are in good agreement with those obtained for (HI, xn) reactions. In reactions leading to Gd compound systems, the straggling parameters are found to be anomalously large. It is suggested that these effects are due to alpha-particle emission from highly excited Gd compound nuclei, and an attempt is made to infer the kinematics associated with this process. The results of a relatively simple analysis of the straggling-parameter data show that the average kinetic energies of the emitted alpha particles are reasonable, but somewhat different for the several reactions investigated. (auth)

15275 SCATTERING OF 64.3-Mev ALPHA PARTICLES FROM NICKEL-58 AND IRON-58. P. Darriulat, G. Igo, H. G. Pugh, J. M. Meriwether, and S. Yamabe (Univ. of California, Berkeley). Phys. Rev., 134: B-42-67(Apr. 13, 1964). (UCRL-11054)

For 64.3-Mev α particles the differential cross sections for elastic scattering and excitation of the first 2^+ collective state were measured for the Ni^{58} and Fe^{58} isobars at approximately 0.5° intervals between 10 and 82° in the center-of-mass system. The measurements were made with sufficient precision to follow the rapid variations and deep minima in the angular distributions, and the data were exhaustively studied for possible errors, an extensive discussion of the uncertainties is given. An analyzed beam (energy spread <100 kev) of high-energy alpha particles was afforded by the Berkeley 88-in. sector-focused cyclotron. The analyzed beam was characterized by high intensity (0.5 μA), small angular divergence (<0.17°), small beam width (0.06 in.), and by small energy variation during the experiment (±100 kev). A precise scattering chamber (typical tolerance <0.01°) and solid-state detectors with small angular acceptance (0.5°) and sufficient energy resolution (150 kev) were used. No attempt was made to fit the angular distributions in detail but approximate fits to the elastic scattering obtained using an optical potential show: (a) It is not possible to account for the differences observed between the elastic scattering cross sections for the two isobars merely in terms of their different charge or charge distribution. (b) At large angles the elastic scattering from Fe^{58}, about half as intense as from Ni^{58}, can be qualitatively described by using a deeper absorptive potential for Fe^{58}. Analysis of the elastic- and inelastic-scattering cross sections for $\theta_{c.m.}<50°$ using the smooth cutoff model of Blair, Sharp, and Wilets give the quadrupole deformation parameter β as 0.15 (Ni^{58}) and 0.17 (Fe^{58}). (auth)

15276 SPIN STATES OF NEUTRON RESONANCES IN GADOLINIUM AND EUROPIUM. Alexander Stolovy (Naval Research Lab., Washington, D. C.). Phys. Rev., 134: B68-74(Apr. 13, 1964).

The spin states associated with several neutron resonances in gadolinium and europium were assigned by observing the transmission of polarized neutrons through polarized targets. For the levels in Gd^{155} at 0.0268, 2.01, 2.57, and 6.30 ev, the spin states were found to be J = 2, 1, 2, and 2, respectively, and for the 0.0314-ev level in Gd^{157}, J = 2. For the resonances in Eu^{151} at 0.32, 0.46, 1.06, and 3.37 ev, the spin states were found to be J = 3, 3, 3, and 2 respectively, and for the negative level J = 3. For the 2.46-ev resonance in Eu^{153}, J = 3. There appears to be no correlation between these measured spin states and other resonance parameters. The magnitude and direction of the observed effects are discussed in terms of the effective magnetic field at the nucleus and the magnetic properties of the metals at low temperature. (auth)

15277 DISSOCIATION OF Li^6. R. W. Ollerhead, C. Chasman, and D. A. Bromley (Yale Univ., New Haven). Phys. Rev., 134: B74-89(Apr. 13, 1964).

Interactions of Li^6 ions with carbon and nickel targets were investigated at incident Li^6 energies of 36 and 63 Mev, utilizing a (dE/dx) × E product identification system capable of separating individual product isotopes. Contrary to expectations based on previous studies on the $Li^6(Li^6,d)B^{10}$ reaction at 6 Mev, which demonstrated a direct reaction mechanism involving the transfer of an alpha particle, no evidence was obtained in the experiments reported for deuteron groups corresponding to population of isolated residual states. Each deuteron energy spectrum exhibited a single broad peak, centered at an energy corresponding to the beam velocity, indicating that a direct dissociation mechanism dominates lithium interactions at these higher energies, thus precluding use of Li^6 ions at high energies as nuclear spectroscopic probes. The total dissociation cross section for 63-Mev Li^6 ions on carbon, for example, was found to be 24% of the total geometric cross section. In order to establish whether the Li^6 dissociation proceeds sequentially through well-defined excited states, the elastic and inelastic scattering both of a C^{12} beam from a Li^6 target, and of a Li^6 beam from a carbon target, were studied. These data demonstrate that processes wherein binary

dissociation follows inelastic excitation of unbound Li^6 states can account for less than 5% of the observed events. It is concluded that the dissociation mechanism is a direct one, reflecting strong alpha-particle plus deuteron-cluster amplitudes in the Li^6 wave function. Analysis of the dissociation product angular distributions suggests that the dominant interaction involved in these studies is nuclear scattering of the center of mass of the Li^6 ion from the target. Preliminary studies on the dissociation of Li^7 and of B^{10} and B^{11} were also carried out; in each case, an alpha particle is again a dominant dissociation product. (auth)

15278 BINARY FISSION STUDIES OF HELIUM-ION-INDUCED FISSION OF Bi^{209}, Ra^{226}, and U^{238}. J. P. Unik and J. R. Huizenga (Argonne National Lab., Ill.). Phys. Rev., 134: B90-9(Apr. 13, 1964).

The kinetic energies of coincident fission fragments were measured for helium-ion-induced fission of Bi^{209}, Ra^{226}, and U^{238} with gold surface-barrier detectors and an Argonne three-parameter analyzer. The data obtained at each bombarding energy were analyzed to give total kinetic energy and mass yield distributions for fixed values of the average total kinetic energy, and total kinetic-energy distributions as a function of heavy fragment mass M_H. The mass yield distributions for Bi^{209}, U^{238}, and Ra^{226} are single, double, and triple humped, respectively. The total kinetic-energy release for Bi^{209} fission decreases smoothly with increasing values of M_H and its variance remains constant. The total kinetic energy as a function of M_H for all the bombardments of Ra^{226} and U^{238} show structure with a maximum value at $M_H = 135$, while each bombardment gives a maximum in the variance of the total kinetic energy at $M_H = 131$. This structure in the kinetic energy for Ra^{226} and U^{238} is interpreted in terms of shell structure in the heavy fragment. The larger kinetic energy observed for symmetric fission of heavy elements with energetic particles over that observed for thermal neutron fission is assumed to be due to a smaller effective separation of charge centers at the scission configuration. This effect may possibly result from a temperature-dependent viscosity and tensile strength of the nuclear fluid and leads to the interesting speculation that information on these parameters may be inferred from nuclear fission data. The full width at half-maximum height in the total kinetic-energy distribution for 42-Mev helium-ion-induced fission of Bi^{209} is 16 ± 1 Mev (corrected for neutron emission and experimental dispersion) in excellent agreement with a theoretical calculation of Swiatecki and Nix. (auth)

15279 SEARCH FOR PHOTODEUTERIUM FROM COPPER. James Shannon (Univ. of Pennsylvania, Philadelphia), W. E. Stephens, and James S. O'Connell. Phys. Rev., 134: B113-17(Apr. 13, 1964).

Copper foil samples were irradiated with bremsstrahlung of 24-, 30-, and 40-Mev peak energy, and production of deuterium by the (γ,d) reaction investigated. After irradiation, gas released from the samples was introduced into an omegatron mass spectrometer and the ion currents HHD^+ and HH^+ measured. The sensitivity of the detection was sufficient to use the amount of deuterium in natural hydrogen as calibration. No HHD^+ was observed after irradiation at 24 and 30 Mev and the ratio of deuterium to hydrogen in the irradiated samples was estimated to be less than 0.0016 and 0.00014, respectively. At 40 Mev the ratio was measured to be approximately 0.0009. The ratio of deuterium to hydrogen expected on an evaporation theory was calculated for several level density formulas. The predicted values are much greater than the observed deuterium to hydrogen ratio. It is concluded that deuterons are not evaporated from copper at these photon energies. The direct photointeraction pickup process of Madsen and Henley is estimated to predict a ratio of deuterium to hydrogen of 0.0012 at 40 Mev and 0.0003 at 30 Mev for relatively high residual nucleus excitations. Such predictions seem consistent with the experimental results. (auth)

15280 INELASTIC PROTON SCATTERING FROM NUCLEI WITH 28 NEUTRONS. H. O. Funsten, N. R. Roberson, and E. Rost (Princeton Univ., N. J.). Phys. Rev., 134: B117-32(Apr. 13, 1964). (PUC-1963-116)

The inelastic scattering of 17.45 Mev protons from Ti^{50}, Cr^{52}, Fe^{54}, and V^{51} was measured. Levels up to 5-Mev excitation were studied and the 30°-90° differential cross sections were measured for most of the levels. Spins and parities were assigned on the basis of the angular distributions and agree well with other experiments. The strength of the various inelastic cross sections were studied using a direct reaction theory with distorted waves. Both the collective model and the shell model of nuclear structure were used to describe the nuclear states. In describing the excitation of the strongly excited levels of the even-A nuclei, the collective model picture yielded a strength parameter, β_l, which agreed within experimental error with the β_l value extracted from Coulomb excitation experiments. The shell-model formulation described these data as well using a two-body Gaussian potential of finite range and depth of 45 Mev. The analysis of V^{51}, however, was better explained using a shell-model analysis. (auth)

15281 POSITIONS AND WIDTHS OF O^{16} LEVELS UP TO 15-Mev EXCITATION. C. P. Browne and I. Michael (Univ. of Notre Dame, Ind.). Phys. Rev., 134: B133-41 (Apr. 13, 1964).

Protons from the $N^{14}(He^3,p)O^{16}$ reaction were analyzed with a broad-range spectrograph. Results from 10 runs were averaged to give positions of 23 levels and the widths of 11 of these, which are more than 12 kev wide. Two levels were found near 11 Mev with a spacing of 16.0 ± 0.5 kev. Excitation energies were 6 to 15 Mev. A new level in O^{16} was found, precise excitation energies are given, and width measurements are confirmed for levels broader than 10 kev. (auth)

15282 REACTION ENERGIES AND ENERGY LEVELS FROM PROTON AND DEUTERON BOMBARDMENT OF THE IRON ISOTOPES. A. Sperduto and W. W. Buechner (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 134: B142-63(Apr. 13, 1964). (TID-19541)

Thin targets of natural iron and of iron oxide enriched in Fe^{54}, Fe^{57} and Fe^{58} were bombarded with protons and deuterons at several energies between 6.5 and 8.5 Mev. Reaction protons and alpha particles from the (p,p'), (p,α), and (d,p) reactions were analyzed with a broad-range magnetic spectrograph at a number of angles between 30 and 130 deg with respect to the incident beam. The (p,p') and (d,p) reactions gave information on the excited states of Fe^{54}, Fe^{55}, Fe^{56}, Fe^{57}, Fe^{58}, and Fe^{59}. For these isotopes, the regions of excitation studied extended from their ground states to 4.07, 7.47, 4.74, 5.80, 8.18, and 4.87 Mev, respectively, and the numbers of levels whose energies were measured in these regions were 11, 136, 25, 109, 133, and 64, respectively. Alpha-particle groups were observed that were associated with excited states in Mn^{53} at 0.380 Mev; in Mn^{54} at 0.057, 0.162, and 0.402 Mev; and in Mn^{55} at 0.128 Mev (all ±0.012 Mev). Also, from (p,p') scattering from tungsten present in the targets, proton groups were identified whose energies corresponded to levels in W^{182}, W^{184},

and W^{186} at 0.100, 0.111, and 0.122 Mev, respectively (all ±0.004 Mev). The ground-state Q values of the reactions studied were found to be:

$Fe^{54}(d,p)Fe^{55}$ $Q_0 = 7.084 \pm 0.008$ Mev,
$Fe^{56}(d,p)Fe^{57}$ $Q_0 = 5.425 \pm 0.008$ Mev,
$Fe^{57}(d,p)Fe^{58}$ $Q_0 = 7.815 \pm 0.008$ Mev,
$Fe^{58}(d,p)Fe^{59}$ $Q_0 = 4.357 \pm 0.008$ Mev,
$Fe^{56}(p,\alpha)Mn^{53}$ $Q_0 = 1.060 \pm 0.009$ Mev,
$Fe^{57}(p,\alpha)Mn^{54}$ $Q_0 = 0.237 \pm 0.009$ Mev,
$Fe^{58}(p,\alpha)Mn^{55}$ $Q_0 = 0.402 \pm 0.009$ Mev.

(auth)

15283 DIRECT INTERACTIONS WITH THREE-PARTICLE FINAL STATES. M. M. Duncan (Univ. of Georgia, Athens), J. L. Duggan, and R. D. Purrington. Phys. Rev., 134: B164-6(Apr. 13, 1964).

Momentum and angular distributions were calculated for a reaction of the type $Li^7(He^3,np)Be^8$ using a plane-wave stripping-type interaction. These calculations are compared to the neutron time-of-flight data for this reaction that were measured at an incident He^3 energy of 2 Mev. (auth)

15284 STUDY OF A FRAGMENTATION REACTION BY THIN-TARGET RECOIL TECHNIQUES; PRODUCTION OF Na^{24} FROM BISMUTH BY 2.9-Gev PROTONS. J. B. Cumming, R. J. Cross, Jr., J. Hudis, and A. M. Poskanzer (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 134: B167-74(Apr. 13, 1964). (BNL-7528)

The angular distribution of Na^{24} nuclei produced by bombardment of thin bismuth targets with 2.9-Bev protons was measured. The forward-to-backward ratio in the laboratory system was found to be 1.52 ± 0.06. Differential range curves for the Na^{24} nuclei were obtained at angles of 15, 90, and 165°, with respect to the beam direction. The mean energy of emission at 90° is 47 Mev with a full width at half-maximum of 40 Mev. The mean is only 60% of the energy expected from Coulomb repulsion. Velocity spectra at 15 and 165° are nearly identical to the 90° spectrum linearly shifted by ≈10% to higher and lower velocities, respectively. From the analysis of the angular distribution and the range data, it is concluded that there is no moving system in which both the angular distribution and velocity spectra of the Na^{24} nuclei are symmetric about the direction perpendicular to the beam. This indicates that this typical fragmentation product is produced by a direct (rapid) process and not by the usual fast nucleonic cascade followed by a slower de-excitation step. (auth)

15285 RELATIVISTIC HIGH-ENERGY APPROXIMATION FOR ELASTIC SCATTERING OF DIRAC PARTICLES. Adolph Baker (Brandeis Univ., Waltham, Mass.). Phys. Rev., 134: B240-51(Apr. 13, 1964).

A high-energy approximation is described for predicting the elastic scattering of Dirac particles by a scalar potential. The formal solution is then applied to the specific problem of electron and positron scattering from nuclei. The predicted cross sections turn out to be in close agreement with those of partial-wave analysis, even for heavy nuclei and at large scattering angles, where the Born approximation is entirely inadequate. (auth)

15286 GAMMA-RAY SPECTRA FROM SPONTANEOUS FISSION OF ^{252}Cf. Harry R. Bowman, Stanley G. Thompson, and John O. Rasmussen (Univ. of California, Berkeley). Phys. Rev. Letters, 12: 195-8(Feb. 24, 1964). (UCRL-11203)

Prompt gamma peaks associated with fission fragments of selected masses from the spontaneous fission of Cf^{252} are studied. The dependence of the Doppler shift of the radiation energy on the fragment direction and mass is used to interpret the spectra. (R.E.U.)

15287 EXCITATION OF ISOBARIC ANALOG STATES IN ^{89}Y AND ^{90}Zr. J. D. Fox, C. F. Moore, and D. Robson (Florida State Univ., Tallahassee). Phys. Rev. Letters, 12: 198-200(Feb. 24, 1964).

The excitation of compound-nucleus resonances in Y^{89} and Zr^{90} by proton bombardment at 4 to 5.5 Mev of Sr^{88} and Y^{89}, respectively, is reported. Shell-model configurations were used to interpret the results. (R.E.U.)

15288 PROPERTIES OF HIGH-SPIN ROTATIONAL STATES IN NUCLEI. F. S. Stephens, N. Lark, and R. M. Diamond (Univ. of California, Berkeley). Phys. Rev. Letters, 12: 225-9(Mar. 2, 1964).

Targets of Tb^{159}, Ho^{165}, and Tm^{169} and projectiles of B^{11}, N^{14}, and F^{19} were used to produce Yb^{166}, $Hf^{166, 168, 170, 172}$, and $W^{172, 174, 176}$. The conversion-electron and gamma-ray spectra were studied for the targets during a 3-msec beam burst. Transitions with high probability of association with the ground-state rotational band were studied. Identification up to spin 14 was accomplished. (R.E.U.)

15289 POLARIZATION IN HIGH-ENERGY INELASTIC SCATTERING. R. M. Haybron (Michigan State Univ., East Lansing), H. McManus, A. Werner, R. M. Drisko, and G. R. Satchler. Phys. Rev. Letters, 12: 249-51(Mar. 9, 1964).

Spin-dependent distortion effects were studied in the polarization produced in the excitation of the 2^+ level of C^{12} at 4.43 Mev. (R.E.U.)

15290 THE INTERACTION OF STRANGE PARTICLES WITH NUCLEI. E. H. S. Burhop (Univ. of London), D. H. Davis, and J. Zakrzewski. Progr. Nucl. Phys., 9: 155-255 (1964).

The capture of negatively charged particles by nuclei, the interactions of K^--mesons with nuclei, properties of hyperfragments and the Λ^0-N interaction, interactions of K^+-mesons and Σ-hyperons with nuclei, and the use of strange particles as probes for nuclear studies are discussed. 175 references. (R.E.U.)

15291 ON THE MANY-BODY FORCES IN HEAVY NUCLEI. Kenji Hasegawa (Fukui Univ., Japan). Progr. Theoret. Phys. (Kyoto), 30: 827-35(Dec. 1963).

A contribution to internucleon potentials due to many-body forces in heavy nuclei is calculated from semiphenomenological πN interactions using nonrelativistic perturbation theory. p-wave interactions are considered only in the lowest order, while s-wave interactions are treated by taking their average over a Fermi distribution at the outset. This approximation leads to a large increment of the effective mass of the pion. The Pauli principle is taken into account for the intermediate states. The resultant effective two-body potential is shown graphically. (auth)

15292 ISOTOPE EFFECTS ON (n,2n) REACTIONS IN ANTIMONY. V. D. Nefedov, I. M. Rozman, Yu. A. Ryukhin, and E. A. Makoveev. Radiokhimiya, 5: 643-6(1963). (In Russian)

The variations in the behavior of the nuclear recoil of antimony in the reactions $Sb^{121}(n,2n)Sb^{120}$, $Sb^{121}(n,2n)Sb^{120m}$, and $Sb^{123}(n,2n)Sb^{122}$ were investigated. Antimony in the form of the compound $Sb(C_6H_5)_3Cl_2$ was bombarded with fast neutrons for 6 to 8 hours. The decay schemes and activity curves of Sb^{120}, Sb^{120m}, and Sb^{122} are illustrated. (C.E.S.)

15293 TRANSFORMATION BRACKETS BETWEEN CARTESIAN AND ANGULAR MOMENTUM HARMONIC OSCILLATOR BASIS FUNCTIONS WITH AND WITHOUT SPIN-ORBIT COUPLING TABLES FOR THE 2s-1d NUCLEAR SHELL. E. Chacón and M. de Llano (Universidad de Mexico, Mexico City). Rev. Mex. Fix., 12: 57-68(1963).

Orbital wave functions of a single particle in a harmonic oscillator potential are given in terms of spherical components of a creation vector operator acting on the ground state. The wave functions are given in different bases. Numerical coefficients for transforming from one basis to another are given in tabular form for principal quantum $\nu = 2$. Wave functions for spin-orbit coupling are also considered. (auth)

15294 ENERGY LEVELS IN ^{46}Sc FROM THE ^{45}Sc(d,p)^{46}Sc REACTION. M. Mazari (Universidad Nacional de Mexico, Mexico City), W. W. Buechner, and A. Sperduto. Rev. Mex. Fis., 12: 99-108(1963).

A total of 120 energy levels of Sc^{46}, having energies up to 7.6 Mev, are determined from analysis of the reaction $Sc^{45}(d,p)Sc^{46}$ at an incident deuteron energy of 6.5 Mev. The measurements are made using a single-gap broad-range magnetic spectrograph. (T.F.H.)

15295 REDUCED WIDTHS FOR THE DISINTEGRATION $Be_4^8 \rightarrow 2\alpha$ CALCULATED IN THE SHELL MODEL WITH INTERMEDIATE COUPLING. I. Brandus, M. Iosifescu, A. Sandulescu, and M. Stihi (Inst. of Atomic Physics, Bucharest). Rev. Phys., Acad. Rep. Populaire Roumaine, 8: 431-44(1963). (In French)

Wave functions for Be^8 are derived and used to calculate the reduced widths for disintegration into two alpha particles from the I = 0, 2, and 4 states. The results are compared with experimental data. (tr-auth)

15296 MEASUREMENT OF THE CROSS SECTION OF THE REACTION $Ti^{47}(n,p)Sc^{47}$. L. Gonzalez, A. Trier, and J. J. van Loef (Universidad, Santiago, Chile and Philips Research Labs., Eindhoven, Netherlands). Scientia (Valparaiso, Chile), 29: No. 118, 36-41(Apr.-June 1962). (In Spanish)

The cross section for the reaction $Ti^{47}(n,p)Sc^{47}$ was measured for neutron energies between 2.0 and 3.6 Mev. The experimental method used in the measurements is described in some detail and shown schematically. The results are tabulated and given graphically. An analysis of the results suggests that the ground state and, possibly, the first excited state of the residual nucleus contributes predominantly to the cross section. (J.S.R.)

15297 MÖSSBAUER LINE SHAPE ASSOCIATED WITH THE SPREAD IN LOCAL VALUES OF ∇E. S. V. Karyagin (Inst. of Chemical Physics, Moscow). Soviet Phys.-Solid State (English Transl.), 5: 1552-4(Feb. 1964).

Using the example of magnetic dipole γ transitions $3^+/2 \rightarrow 1^+/2$, the form of the Mössbauer spectrum is calculated with a spread of local values of ∇E. (In the absence of this spread, the lines are assumed to be infinitely narrow, i.e., other factors that broaden a line are not taken into account.) It is shown that the two peaks obtained in this treatment have different forms if the Mössbauer factor is anisotropic. A formula is obtained for determining the degree of spread in ∇E from measurements of the spectrum. (auth)

15298 ABSORPTION OF π^+ MESONS WITH ENERGY OF 80 Mev BY CARBON NUCLEI. R. G. Salukvadze and D. Niyagu. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 9: 77-84(1963). (In Russian)

The stars produced by π^+-mesons with the energy of 78 ± 3 Mev at their absorption by carbon nuclei were investigated by means of a small propane bubble chamber. The results are based on the analysis of 201 interaction events. (auth)

15299 STUDY OF (α,d) REACTION FOR SOME LIGHT NUCLEI. T. I. Kopaleishvile and I. G. Ratishvili. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 9: 97-109(1963). (In Russian)

The angular distributions of knocked-out deuterons are calculated in the case of nuclei for which the representation core + d is valid. The independent interaction of the bombarding α particle with the core and extra core deuteron is assumed. Numerical results are given for the nuclei of Li^6, N^{14}, and B^{10}. The theoretical curves are compared with the experimental ones, showing a good agreement for small angles. (auth)

15300 THE CLASSICAL SCATTERING FORMULA FOR A COULOMB POTENTIAL WHICH IS CUT OFF AT RADIUS D. Heinz-Guenter Maennig, Wolfgang Julius Caesar Mueller, and Joachim Schroeter (Freie Universität, Berlin). Z. Angew. Phys., 16: 499-503(Jan. 1964).

An expression for the scattering angle θ as a function of the impact parameter b for the case of a shielded Coulomb potential, which is zero outside and proportional to r^{-1} inside a sphere of radius D, $D \neq 0$, was obtained. The method used was similar to that given for a proof of the Rutherford formula by M. M. Gordon (Am. J. Phys. 23, 247(1955)). The result of the computation of $\theta = \theta(b)$ with the help of the conservation theorems for energy and angular momentum is given for reflection at the Coulomb sphere and for entering the Coulomb sphere. (auth)

15301 THE FIELD THEORY FORMULATION OF THE NONRELATIVISTIC MULTICHANNEL SCATTERING THEORY. W. Weidlich (Technische Hochschule, Stuttgart). Z. Naturforsch., 18a: 1266-75(Dec. 1963). (In German)

Methods for the explicit construction of asymptotic fields in terms of the interpolating field in a nonrelativistic theory were derived in both cases of one sort representing many sorts of asymptotic particles. A simple nontrivial multichannel case is discussed explicitly. (auth)

15302 THE ACTIVATION CROSS SECTION OF ARGON-40 FOR THERMAL NEUTRONS. W. Koehler (Technische Hochschule, Munich). Z. Naturforsch., 18a: 1339-44(Dec. 1963). (In German)

There is a great discrepancy between the activation cross section for Ar^{40} (99.6% of natural argon) and the total cross section for argon. For this reason a new determination of the activation cross section of Ar^{40} was carried out. Argon, gold, and sodium samples were irradiated simultaneously in the neutron field of the Munich Research Reactor and the activities of the samples were compared with a gamma counting tube (methane flow proportional counter with lead cathode). With gold as the comparative substance (σ = 98.8 barn) an activation cross section for Ar^{40} of 0.63 ± 0.02 barn was obtained. In the case where sodium was used as a comparative material, good agreement was obtained only when the absorption cross section given in the literature for Na^{23} (0.505 barn) was used. In a separate experiment therefore the activation cross section for sodium was determined and an agreement within the limits of error with the absorption cross section was obtained. The measured activation cross section for Ar^{40} (plus the total cross sections of the less-abundant isotopes) agreed within the limits of error with the total cross section for argon obtained by other methods. (tr-auth)

15303 THE OPTICAL MODEL OF ELASTIC SCATTERING. P. E. Hodgson. New York, Oxford University Press, 1963. 217p. $4.80.

The application of the optical model to elastic scattering of particles by nuclei is studied. Analyses of elastic scattering of nucleons, mesons, and light nuclei by nuclei are reviewed. The treatment is predominantly phenomenological. (T.F.H.)

15304 DERIVATION OF THE GOLDBERGER-TREIMAN RELATION. K. Nishijimi and M. Ida (Univ. of Illinois, Urbana). p.101-7 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

An attempt is made to clarify the derivation of the Goldberger-Treiman relation, which expresses the decay rate in nuclear μ capture. The relation was previously derived from two apparently different assumptions. (C.E.S.)

15305 "ELEMENTARY" PARTICLE THEORY OF NUCLEAR REACTION. F. Coester (Argonne National Lab., Ill.). p.108-13 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

A nuclear reaction theory, based on the assumption that all nuclei are elementary particles, is presented. (C.E.S.)

15306 COULOMB SCATTERING WAVE FUNCTION AS A SERIES IN $(\alpha Z)^2$ AND ARBITRARY BORN PARAMETER. D. M. Fradkin, T. A. Weber, and C. L. Hammer (Ames Lab., Ames, Iowa), p.283-9 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

An expansion in $(\alpha Z)^2$ is obtained for the scattering wave function for a Dirac electron in a Coulomb field. The wave function is valid for all Born parameters. For large r an expression in terms of known functions is obtained for the nonrelativistic limit. (C.E.S.)

15307 THEORY OF COLLECTIVE MOTION IN FINITE MANY PARTICLE SYSTEMS. Abraham Klein (Univ. of Pennsylvania, Philadelphia) and Arthur K. Kerman. Pt. I, p.25-42 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N. C., University of North Carolina, 1963.

A method for studying the possible collective motions of a finite many-particle quantum mechanical system is described. The method is used to investigate the low-lying rotational excited states of deformed nuclei. Generalized Hartree-Fock theory, Hartree-Bogoliubov-Baranger theory of nuclear shapes, and the moment of inertia are discussed. (C.E.S.)

15308 ON THE POSSIBLE EFFECTS OF STRONG INTERACTIONS IN PERATIZATION THEORY. Ngee-Pong Chang (Columbia Univ., New York). Pt. II, p.42-52 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N.C., University of North Carolina, 1963.

It is shown that in the simplest model where strong interaction effects are included in the baryon vertices and propagators only, the peratization of the nuclear vector β-decay coupling strength is no longer equal to the corresponding peratization of the μ-decay coupling strength. This might suggest a vastly different role of strong interactions in the weak interaction (peratization) theory of Feinberg and Pais in order to conform with the observed equality of nuclear vector β-decay and μ-decay strengths. (auth)

15309 ON THE POSSIBLE EFFECTS OF STRONG INTERACTIONS IN PERATIZATION THEORY. [PART] II. N. P. Chang (Inst. for Advanced Study, Princeton, N. J.) and H. S. Mani. Pt. II, p.53-66 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N. C., University of North Carolina, 1963.

A general argument that shows that the final peratized nuclear vector β-decay coupling strength is no longer equal to the peratized μ-decay coupling strength if the vector current is conserved is presented. This conclusion holds when all possible effects of strong interactions, within the framework of peratization theory, are taken into account and when the sum over the crossed ladder graphs is included. (C.E.S.)

15310 A NEW LAMB SHIFT CALCULATION. Glen W. Erickson (Courant Inst. of Mathematical Sciences, New York). Pt. II, p.121-33 of "Proceedings of the Eastern Theoretical Physics Conference." Chapel Hill, N. C., University of North Carolina, 1963.

The calculation of the Lamb shift to second order was carried out more completely than before and is briefly discussed. Previous calculations were verified and the contribution of order $\alpha(Z\alpha)^6 m$ is estimated to be -0.11 Mc (for $Z = 1$), bringing theory into very close agreement with experiment for He^+ and D, while not destroying the agreement for H. (auth)

15311 INELASTIC AND ELASTIC SCATTERING OF PROTONS BY COMPLEX NUCLEI FOR AN ENERGY OF 27 BEV. H. Goeing. Thesis, Munich, Universität, Munich, 1962. 55p. $2.00(Gmelin, AED-DISS. 62-619). (In German)

Two stacks of nuclear emulsions were exposed to a 27-Bev proton beam of the CERN proton synchrotron. It is shown that no cascade processes in nuclei are involved in meson production. The influence of the primary nucleons on the angular distribution of secondary particles was studied. Differential angular distributions of π mesons are given. In the center-of-gravity system no anisotropy was observed. The transversal momentum of the nucleons was 1.2 Bev/c. The average energy of secondary π mesons was 2.18 m_0c^2. A new method for the measurement of total and differential cross sections of emulsion nuclei to high energy protons is described. (Gmelin Inst.)

15312 SOME PROBLEMS RELATED TO THE CONDENSED STATE OF MATTER STUDIED WITH REACTOR NEUTRONS. Karl-Erik Larsson (Royal Inst. of Tech., Sweden). p.255-85 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Various aspects of the use of the neutron scattering process to investigate the condensed state of matter are reviewed. Thermal neutron scattering experiments are discussed, including elastic nuclear scattering, elastic magnetic scattering, inelastic nuclear scattering, magnetic inelastic scattering, and experimental equipment. Fast neutron scattering or irradiation damage is also considered. (61 references) (M.C.G.)

15313 USE OF REACTORS FOR EXPERIMENTS ON FISSILE MATERIAL. G. N. Walton (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.339-59 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Methods of measuring the amount of fission and the phenomena that occur when fissile material is irradiated in reactors are described. Practical aspects of measuring fission yields are considered. The procedure consists

of: irradiation of material, addition of carriers, dissolution, establishment of isotope exchange, analysis to separate carriers, radiochemical purification, estimation of radioactivity relative to a standard, estimation of chemical yield, and calculations. Heating effects during irradiation of fissile material are considered. Fission fragment spikes, displacement spikes, experimental effects by recoil, physical and chemical states of fission products, migration processes, experimental methods, and stable fission products are discussed. (M.C.G.)

15314 RADIATIONS FROM THE DECAY OF Ag^{102}. Prasit Charoenkwan and J. Reginald Richardson (Univ. of California, Los Angeles). 8p. (CONF-417-12)

From American Physical Society Meeting, Pasadena, Calif., Dec. 1963.

The beta and gamma radiations emitted from an isotopically enriched (51%) target of Pd^{102} bombarded by 16-Mev protons were studied. Measurements in a magnetic lens spectrometer indicate that Ag^{102} decays by positron emission with a half life of 13 ± 0.4 min and with an end-point energy of 2.20 ± 0.08 Mev. The following gamma rays were found to decay with the same half-life: 0.51 Mev (100) (annihilation radiation), 0.55 Mev (70), 0.72 Mev (26), 0.84 Mev (4), 1.26 Mev (8), 1.57 Mev (7), 1.77 Mev (7), 2.07 Mev (weak), 2.79 Mev (weak), and 3.33 Mev (weak). The numbers in the parentheses following the gamma energies indicate the relative intensities, taking the annihilation-radiation intensity as 100. Gamma-gamma coincidence experiments indicate coincidences among the 0.55-, 0.72-, and 0.84-Mev gamma rays and between the 0.72- and 1.26-Mev gamma rays. (auth)

15315 GAMMA-GAMMA DIRECTIONAL CORRELATION IN Ba^{134}. L. W. Coleman. 6p. (CONF-417-16)

From American Physical Society Division of Fluid Dynamics, Cambridge, Mass., Nov. 1963.

Two gamma correlations in Ba^{134} were measured and the results were interpreted in the light of the presently accepted level and decay scheme. The results indicate large M1 admixtures in the 563 and 569 kev radiations. (P.C.H.)

15316 OPTICAL POTENTIAL AND DISSIPATION CONSTANTS OF NUCLEAR MATTER. Mikio Namiki (Waseda Univ., Tokyo). 13p. (CONF-327-14)

From Topical Conference on Compounds Nuclear States, Gatlinburg, Tenn., Oct. 1963.

It is shown that there exist direct relationships between the complex optical potential and the macroscopic dissipation constants of the nuclear matter. These are obtained by using the stochastic Hamiltonian characterized by the nuclear Nyquist theorem, without resort to the fundamental interaction among nucleons. (auth)

15317 EXTRAPOLATION OF PROTON ELECTROMAGNETIC FORM FACTORS. J. S. Levinger and R. F. Peierls (Cornell Univ., Ithaca, N. Y.). 61p. (CONF-122-23)

From International Conference on Nucleon Structure, Stanford, Calif., June 1963.

The assumed analytic properties of the proton electromagnetic form factors G(t) are used by performing a conformal transformation to an η-plane, such that the form factor is analytic inside the unit circle. The data are fitted with power series in η and extrapolated to the circle to find the spectral function. For both electric and magnetic form factors, spectral functions are found with a broad peak around 625 Mev, and a negative excursion above 1 Bev. The validity of the extrapolation procedure is examined by tests on several types of artificial data. The procedure can reproduce a spectral function with a broad peak, but is not so successful in reproducing a narrow resonance, or a pair of narrow resonances close together. (auth)

15318 A $T = {}^3/_2$ LEVEL IN Be^9. T. Lauritsen, B. Lynch, and G. Griffiths (California Inst. of Tech., Pasadena). 6p. (CONF-417-2)

From American Physical Society Meeting, Pasadena, Calif., Dec. 1963.

Targets of Li^7 were bombarded with a He^3 beam from a tandem accelerator, and the resulting proton spectrum was studied to determined a $T = {}^3/_2$ level in Be^9 at about 14.5 Mev. (R.E.U.)

15319 NUCLEAR RESONANCE FLUORESCENCE MEASUREMENTS WITH PULSED BEAM TECHNIQUES. S. J. Skorka. 20p. (CONF-354-7)

From Accelerator Conference, Boston, Nov. 1963.

Pulsed-beam experiments using a 3-Mev proton Van de Graaff accelerator are described. The measurement of the width of the 3.56-Mev state of Li^6 and measurement of the lifetime of the first excited state in Si^{29} are reported. (R.E.U.)

15320 NUCLEAR SIZE AND MAGNETIC EFFECTS IN THE RADIATIVE TAIL OF ELECTRON–NUCLEUS SCATTERING. Edw. S. Ginsberg and R. H. Pratt (Stanford Univ., Calif.). 27p. (CONF-417-3)

From American Physical Society Meeting, Pasadena, Calif., Dec. 1963.

The spectrum of scattered electrons due to bremsstrahlung from static nuclear charge and magnetic moment distributions is calculated in Born approximation. Large reductions from point nucleus cross sections are obtained for scattering involving large momentum transfers, and magnetic bremsstrahlung is important in the same large-angle region where magnetic elastic scattering is appreciable. Integrations were carried out numerically on an IBM 7090 computer for some representative cases using form factors from elastic electron scattering. The results may be used in interpreting inelastic electron scattering experiments where the radiative tail of the elastic peak is distinguished from inelastic nuclear processes. (auth)

15321 POLARIZATION OF PROTONS ELASTICALLY SCATTERED FROM THE ISOBARS Ar^{40}–Ca^{40} NEAR 18 Mev. E. T. Boschitz, R. W. Bercaw, and J. S. Vincent (Lewis Research Center, Cleveland). 8p. (CONF-417-10)

From American Physical Society Meeting, Pasadena, Calif., Dec. 1963.

The polarization of 17.5- and 18.6-Mev protons elastically scattered from Ar^{40}–Ca^{40} was determined between 15 and 165° (lab.) by measuring the asymmetries produced in the scattering of a nearly 100% polarized beam. In the forward hemisphere, the polarizations induced by Ar^{40} and Ca^{40} are quite similar to each other at both energies and also to measurements on these nuclei at 14.5 Mev. The similarities do not persist into the backward hemisphere, where the Ar^{40} and Ca^{40} polarizations differ from each other by approximately 30% throughout a 40° range. They are also quite different from the lower energy data. (auth)

Plasma Physics and Thermonuclear Processes

15322 (AD-401695) ENERGY LOSS OF A RELATIVISTIC ELECTRON IN A LORENTZIAN MODEL PLASMA. Clyde A. Morrison (Harry Diamond Labs., Washington, D. C.). Mar. 25, 1963. 17p. (TR-1109)

The energy loss of a relativistic electron in a Lorentz type plasma is calculated by the method of Landau. No relativistic correction was found for a collisionless plasma; however, corrections occur for a plasma with collision losses. (auth)

15323 (AFCRL-63-155) AN AUTOMATIC SYSTEM FOR MEASURING PLASMA PARAMETERS. Technical Report No. 76. W. E. Scharfman (Stanford Research Inst., Menlo Park, Calif.). May 1963. Contract AF19(628)-325. 16p. (AD-408418)

A system for automatic measurement of microwave phase shifts in plasma is described. Other than the components used in a manual system, only a servo loop is required. The phase is controlled by controlling the reflector voltage on a klystron, which in turn controls the microwave frequency. A prototype system that was constructed and tested is described. Results of measurements of phase shift as a function of control voltage and attenuation are presented. (auth)

15324 (CNAEM-13) CORRELATIONS IN PLASMAS. PART III. GREEN'S FUNCTION SOLUTIONS FOR CORRELATION FUNCTIONALS IN BOGOLIUBOV THEORY. Kaya Imre and Ercuement Oezizmir (Turkey. Atomic Energy Commission. Cekmece Nuclear Research Center, Istanbul). Jan. 1964. 26p.

A method that uses a set of eigendistributions in constructing the formal solution of the set of integro-differential equations for the correlation functionals in the context of the Bogoliubov formalism for fully ionized systems interacting via the Coulomb potential is displayed to an arbitrary order in the interaction strength for the homogeneous case. It is indicated that the method is equally applicable to the slightly inhomogeneous systems for which a perturbation series solution can be developed formally. It is also possible to apply this method in solving the initial value problem of the BBGKY hierarchy. The eigendistributions employed are those developed by Van Kampen and Case in connection with the linearized Vlasov equation. Although the resulting Green's function is quite complicated, it exhibits the general structure of the solutions. (auth)

15325 (D1-82-0256) THE HELICAL INSTABILITY OF THE PLASMA COLUMN WITH A FINITE AMPLITUDE. Roy R. Johnson (Boeing Scientific Research Labs., Seattle). June 1963. 103p.

The helical stability of the plasma column in a longitudinal magnetic field is investigated using the macroscopic equations of motion and continuity for ions and electrons. The presence of a finite amplitude helix in the plasma column is postulated, and the conditions for its stability are determined. The functional form of the quasi-steady state plasma density and potential is calculated for each value of the helical amplitude φ. For each value of φ and the applied magnetic field, the wavelength of the helix is allowed to vary in order to calculate the most unstable wavelength. It is then possible to determine the stability criterion for each value of φ. These results are combined with the energy balance equations for the positive column in order to determine the longitudinal electric field as a function of the applied magnetic field. These results are in good qualitative agreement with experiments performed on the positive column. The frequency of the helix is calculated as a function of the applied magnetic field and compared with the experimental findings. This finite amplitude analysis also indicates that the positive column would have a hysteresis effect for a certain range of neutral gas pressures. The internal magnetic field of the helix is also calculated as a function of the applied magnetic field. It is found that the positive column is paramagnetic when the neutral gas pressure exceeds a certain value and the applied magnetic field is increased. (auth)

15326 (D1-82-0323) INJECTED ELECTRON-HOLE PLASMA PROPAGATION VELOCITY AND LIFETIME MEASUREMENTS IN P-TYPE INDIUM ANTIMONIDE. Michael F. Berg (Boeing Scientific Research Labs., Seattle). Dec. 1963. 13p.

A finite time is required to complete the injection of an electron-hole plasma throughout the length of an In–Sb sample. Upon application of an electric field across the sample ends, a cloud of electron-hole plasma forms at the negative contact and progresses down the sample length past two pairs of biased double probes which are spaced a known distance apart. As the front passes a probe pair it produces a decrease in resistance between the pair. This passage is observed as a pulse on a high speed oscilloscope. The measured velocity plotted as a function of applied electric field strength has an asymptotic upper limit of $\sim 6 \times 10^6$ cm/sec. The velocity diminishes exponentially with decreasing electric field asymptotically to the field strength at which injection begins. The lifetime of this plasma as measured by a double pulse technique is ~1 μsec through a density range of 10^{12} to 2.5×10^{13} carriers/cm^3. (auth)

15327 (D1-82-0325) HYSTERESIS IN STABILITY CONDITIONS OF ELECTRON-HOLE PLASMA. Betsy Ancker-Johnson (Boeing Scientific Research Labs., Seattle). Dec. 1963. 44p.

The investigation of the hysteresis occurring in the threshold conditions for the helical instability oscillations in electron-hole plasma was extended. The hysteresis in electric field strength E can exceed 45 v/cm and 50% of the applied E at threshold. By determining the stability-instability boundary in p-type In–Sb as a function of the parallel (or anti-parallel) electric and magnetic field strengths and also the plasma density, the magnetic field induced by the formation of the helical density perturbation is deduced. Resulting displaced loop B-H curves are presented. The magnitude of the induction enhancement B_{hys} can be as large as 165 oersted and 45% of the applied B at threshold. The extent of applied magnetic field (or electric field strength) over which the loops can occur is limited at the high magnetic field end (typically ≤ 600 gauss) by vanishingly small plasma density and at the other end (≥ 280 gauss) by the occurrence of magnetic pinching. The loops are largest at the low magnetic field end. The range of loop energy, defined as the product of E_{hys} and B_{hys}, increases with decreasing plasma cross-sectional area until saturation occurs at a plasma radius of $\sim 3 \times 10^{-2}$ cm. The full range from largest to smallest loop in any one sample is achieved by a relatively small variation in the input energies, the product of the magnetic and electric field strengths at threshold. (auth)

15328 (LRP-10-63) STABILITE D'UNE COLONNE DE PLASMA. MODELE DES PARTICULES LIBRES. (Stability of a Plasma Column. Free-Particle Model). F. Troyon (Laboratorie de Recherches sur la Physique des Plasmas, Lausanne, Switzerland). Dec. 1963. 13p.

The stability of a field-free homogeneous column of plasma confined to an axial static field and the sum of an alternating and static B_θ field is considered in the free-particle model. Conditions for the existence of a positive average restoring force are derived, and it is shown that

for small deformations the column is stable for sufficiently high frequency. (auth)

15329 (LRP-11-63) SUR LA STABILITE D'UN SYSTEME LINEAIRE PASSIF DONT UN ELEMENT CHANGE PERIODIQUEMENT. (Stability of a Dissipative Linear System with a Periodically Changing Element). F. Troyon (Laboratorie de Recherches sur la Physique des Plasmas, Lausanne, Switzerland). Dec. 1963. 16p.

The stability of a dissipative system with a periodically changing "condenser" is investigated. Conditions are given that ensure that the system is stable for a sufficiently high excitation frequency. Two special cases are discussed. The hypotheses were chosen in view of applications to plasma physics. (auth)

15330 (LRP-12-64) STABILITE D'UNE COUCHE DE PLASMA CONFINEE PAR UN CHAMP TOURNANT. MODELE ACOUSTIQUE. (Stability of a Layer of Plasma Confined by a Rotating Field. Acoustic Model). F. Troyon (Laboratorie de Recherches sur la Physique des Plasmas, Lausanne, Switzerland). Jan. 1964. 16p.

The acoustic normal impedances of a half-plane and of a slab of gas taking into account the viscosity are calculated, using convenient boundary conditions at the second boundary for the slab. The analytical properties of the impedance in the complex frequency plane are investigated. It is then shown that for high enough frequency, assuming no penetration of the rotating magnetic field which confines the plasma, the surface is stable against small perturbations. The influence of thermal conductivity is briefly discussed. The problem of the accelerated plasma is also discussed. (auth)

15331 (MATT-225) A FAST ACTING ULTRA-HIGH VACUUM GAS INLET VALVE AND ITS USE IN THE PRODUCTION OF SPECIAL NON-STATIONARY PRESSURE DISTRIBUTIONS IN THE C STELLARATOR. G. Lewin and D. Mullaney (Princeton Univ., N. J. Plasma Physics Lab.). Oct. 1963. Contract AT(30-1)-1238. 15p. (CONF-209-24)

From American Vacuum Society Meeting, Boston, Oct. 1963.

The C stellarator vacuum system is equivalent to a long tube with a gas injection valve at one end, and a larger volume with pumps at the other end. The gas is admitted in a short burst of 10 to 50 msec duration, and the machine is energized before an excessive amount of gas reaches the volume at the end of the tube. A description is given of the design of the valve and the theoretical analysis of the transient pressure distribution before and after the stellarator is energized. This is an example of the calculation of the transient behavior of a vacuum system with distributed volume. (auth)

15332 (MATT-249) PRELIMINARY RESULTS ON THE INTERPRETATION OF LOW-FREQUENCY FLUCTUATIONS OBSERVED IN THE REFLEX ARC. Francis F. Chen (Princeton Univ., N. J. Plasma Physics Lab.). Jan. 1964. Contract AT(30-1)-1238. 19p.

Observations of electrostatic fluctuations in reflex discharges in the L-1 and L-2 machines are reviewed. A treatment of fluctuations in partially ionized gas in magnetic field is presented which assumes the fluctuations to be drift instabilities driven by the radial electric field. A picture of how the instabilities are generated is given. (D.L.C.)

15333 (N63-20250) CURRENT SHEATH DYNAMICS AND MAGNETOSONIC OSCILLATIONS IN MAGNETOPLASMAS. Otto M. Friedrich, Jr. and A. A. Dougal (Texas. Univ., Austin). [1963]. 25p.

An experimental study of the dynamics of a current sheath and possible magnetosonic oscillations that result from the current sheath moving in an external magnetic field is described. The laboratory equipment required to produce and investigate the dynamic properties of a current sheath in a steady, stabilizing field is outlined. Three aspects of a current sheath are being investigated analytically: the dynamics of a highly ionized current sheath—the calculation of position, velocity, and other physical parameters as functions of time; the formation of a current sheath; and the stability of a current sheath with finite resistivity. (auth)

15334 (N63-20251) ANALYSIS OF WAVES IN BOUNDED MAGNETOACTIVE PLASMA. Y. J. Seto and A. A. Dougal (Texas. Univ., Austin). [1963]. 22p.

A preliminary analysis of radially propagating waves in a bounded magnetoactive plasma is presented. The case of a partially ionized plasma slab, bounded by two infinitely large conducting plates of infinite separation is considered. The plates may be in direct contact with the plasma or insulated from it by thin layers of dielectric materials; and the static magnetic field is normal to the plates. The waves are generated by a current source in the plasma with an arbitrary current distribution. A homogeneous wave equation in anisotropic media is modified to include a source present in the plasma region, and the resulting inhomogeneous wave equation is treated using Green's dyadic function. The results can be extended to analyze waves generated by a current sheet source of finite width using elliptical coordinates, and to analyze waves generated by a semi-infinite sheet of current using parabolic cylindrical coordinates. (auth)

15335 (NP-13624) MAGNETOGASDYNAMIC BOUNDARY CONDITIONS AT A CONDUCTING WALL. Report No. 2. Theodore Ernest Luzzi, Jr. (Columbia Univ., New York. School of Engineering and Applied Science). 1963. 125p.

Velocity boundary conditions at a conducting wall were developed for the continuum magnetogasdynamic equations. The wall is separated from the fully ionized plasma by a Langmuir type sheath. The effect of the sheath on the single fluid plasma boundary conditions is studied. The effects of chemistry and heat transfer in the vicinity of the wall are ignored. The potential of the wall may be either greater than, or less than, that of the plasma. Boundary conditions were developed for both cases. For the case in which the wall potential is greater than the plasma it is possible to have a slip velocity at the wall where no-slip would occur in an equivalent nonionized gas flow. The MHD equations were solved with the above boundary conditions for the case of plasma flow between two parallel conducting plates held at a potential difference. The lower potential plate (cathode) is a thermionic current emitter. Depending upon the potential difference between the plates and the cathode thermionic emission current, the anode potential is either greater than that of the plasma and slip occurs or it is less than that of the plasma and no-slip occurs. A slip-no slip theorem was derived for the flow of plasma over many generally shaped bodies, some of which are cathodes and the others anodes. (auth)

15336 (NP-13631) OPSLUITING VAN PLASMA MET BEHULP VAN EEN DRAAIEND MAGNEETVELD. (Plasma Confinement by Means of a Rotating Magnetic Field). Rijnhuizen Report 64-16. P. C. T. Van Der Laan (Stichting Voor Fundamenteel Onderzoek der Materie. Instituut Voor Plasma-Fysica, Jutphaas, Netherlands). Jan. 1964. 75p.

The field and density distributions in the boundary layer of an alternating pinch plasma were calculated for large

and small values of ν_c/ω, where ν_c is the electron-ion collision frequency and ω is the frequency of the applied field. If $\nu_c \gg \omega$, shear is produced in the magnetic lines of force in the skin. For a plasma column in equilibrium, the calculated field distribution satisfies, under certain conditions, the stability criterion of Suydam. From this result a number of requirements for alternating pinches can be derived. The validity of the theory is discussed, and the equilibrium of an alternating pinch in toroidal geometry is calculated. Experiments were carried out in a torus covered with a metal shell. Around the torus two helical coils were wound, through which damped alternating currents at about 80 kc/sec passed. Depending on the phase shift between these currents a z-pinch, a θ-pinch or an alternating pinch was produced. The mutual inductance of the two helical coils, in the presence of a discharge, should be low. In the experimental arrangement, the derived stability requirements were not met. Therefore, the formation of the column was primarily studied. As a result of the initial conditions, caused by the use of the helical coils, a wide column with a large trapped field was produced, which inhibits a comparison between theory and experiment. In a second arrangement the theoretical requirements can be fulfilled. Furthermore, a set of "orthogonal coils" is used. Now in the initial phase, before the field starts to rotate, a θ-pinch is produced. This first stage of the alternating pinch is extensively studied (in H_2 and He, with and without a predischarge). The temperature of the plasma is derived from the outward directed acceleration of the column in the inhomogeneous B_z-field and from measurements of relative intensities of spectral lines in He. The mass of the plasma is obtained from the period of the radial oscillations of the column. In He all the gas is trapped in the pinch; in H_2 the measurements indicate an incomplete trapping. However microwave measurements show that even in H_2 the electron density outside the column is low ($<10^{20}/m^3$). Measurements on the (unstable) z-pinch are described. If only one of the helical coils is energized a screw pinch is produced. During the first half period (6 μsec) this pinch, according to magnetic probe measurements and streakpictures, is in equilibrium and completely reproducible. The drift of a plasma in a curved magnetic field is analyzed. The calculation of the outward bound acceleration is valid for arbitrary values of β and for an arbitrary density distribution in the column. (auth)

15337 (NP-13646) BACK-SCATTERING BY A CORRUGATED PLASMA CONFIGURATION—HOMOGENEOUS PLASMA, NORMAL INCIDENCE, LONG CORRUGATION WAVE LENGTH. Technical Report No. 394. F. Lane, S. Mariano, and G. Weilerstein (General Applied Science Labs., Inc., Westbury, N. Y.). Jan. 6, 1964. Contract NOw63-0637-c(FBM). 55p.

The back-scattering from a cylindrical plasma structure of a plane wave incident normally to the plasma centerline was calculated. The variation of the backscattering with electron density and axial position was computed for several plasma frequencies, geometries, and receiver locations. (D.C.W.)

15338 (SIT-119) OSCILLATIONS OF A PLASMA COLUMN. R. Landau and G. Schmidt (Stevens Inst. of Tech., Hoboken, N. J.). [1963]. Contract AT(30-1)-2813. 20p.

The effects of retardation of the electromagnetic field are investigated. The physical mechanisms involved in the peculiar behavior of the static mode at long wavelength and the appearance of radiative modes are specifically considered. The transition from the finite column to the infinite uniform plasma case is also discussed. (auth)

15339 (TID-19973) RESONANCES OF A CYLINDRICAL PLASMA COLUMN. F. W. Crawford (Stanford Univ., Calif. Microwave Lab.). June 1963. Contract AT(04-3)-326. 60p. (ML-1045)

Research on resonances in a plasma column subjected to a transverse electric field is reviewed. In addition to the main dipole resonance, three classes of resonances are distinguished: higher order multipole resonances, longitudinal propagation effects, and Tonks-Dattner (T-D) resonances. A hypothesis for the origin of the T-D resonances is advanced that explains much of the experimental work. The explanation was verified by additional experiments. A full theory of the T-D resonances may be impracticable, but a simplified theory is presented. Calculations based on this approach the experimental results. 43 references. (auth)

15340 (TID-20292) PRELIMINARY EXPERIMENT ON THE INTERACTION BETWEEN A LOW-ENERGY ELECTRON BEAM AND A CLOUD OF COLD ELECTRONS IN A MAGNETIC FIELD. Technical Report No. 253-2. Richard Geller (Stanford Univ., Calif. Electron Devices Lab.). Apr. 1963. Contract AT-326 PA-8. 8p. (SEL-63-045)

The possibility that anomalous plasma diffusion across a magnetic field results from interaction of two electron populations at different temperatures, leading to instability, was investigated. A monoenergetic electron beam with variable energy was injected into a cloud of comparatively cold, but Maxwellian electrons in a magnetic field parallel to the beam. The onset of instability at a critical magnetic field was observed, together with an increase in instability frequency with further critical field increases. However, no firm conclusions were possible. (D.C.W.)

15341 (TID-20293) PARTICLE ORBITS IN THE STATIC SHEET PINCH. Technical Report No. 256-1. D. R. Dobrott (Stanford Univ., Calif. Electron Devices Lab.). Apr. 1963. Contract AT(04-3)-326-PA-8. 63p. (SEL-63-035)

The theoretical model of a static, self-confined, neutral, collisionless, current-carrying plasma sheet is derived from certain symmetry considerations. This confinement or pinch is self-consistent with Maxwell's equations. Various aspects of the resulting nonuniform magnetic field are discussed. A constant magnetic field applied along the direction of motion of the counterstreams of ions and electrons does not affect this configuration. The individual particle motions are examined, and the various types of orbits are discussed. An approximate solution for the motion of particles, whose excursion in the nonuniform direction is small compared to the magnetic Debye length, is found. This approximate result is found to qualitatively exhibit all the characteristics of the various orbits, even near the null-field region. A time average for these small-excursion solutions yields the classical result for particle guiding-center drifts in the presence of a nonuniform magnetic field. A numerical integration of the exact equation of motion is compared with the small-excursion theory. (auth)

15342 (TID-20316) THERMONUCLEAR PLASMA STUDIES. Quarterly Status Report No. 4. (Wisconsin. Univ., Madison). Jan. 31, 1964. Contract AT(11-1)-1233. 12p.

Calibration of the magnetic field strength within a toroidal octupole was carried out and the electric characteristics were examined. Tests of the motion of hoops under magnetic fields and on rebound indicated the necessity for some changes. Some changes in the structure were found to be necessary and after that, plasma was injected

without difficulty. Theoretical studies were continued, using a digital computer, on the stability of plasmas in minimum magnetic field configurations such as the toroidal octupole. Theoretical studies were also made on boundary layers. Radiofrequency experiments with plasma-containing devices are also progressing. Solutions are being sought for nonlinear Vlasov equations describing a cylindrical plasma contained in an externally uniform magnetic field. (M.C.G.)

15343 (UCRL-7414) A METHOD FOR CONTINUOUS MEASUREMENT OF PLASMA POTENTIAL OVER A RANGE OF 0 TO 4 kV. A. F. Waugh and A. H. Futch (California. Univ., Livermore. Lawrence Radiation Lab.). June 19, 1963. Contract W-7405-eng-48. 12p. (CONF-363-16)

From International Symposium on Plasma Phenomena, San Diego, Calif., Oct. 1963.

A system is described for continuously measuring plasma potential over a 4-kv range using conventional components and equipment. The time resolution of the measurement is presently 1 msec, but could be made 0.1 msec without serious difficulty. The lithium-ion-beam transmission technique is used. The ion-beam energy is varied from 0 to 4 kv by a saw-tooth generator at a frequency of 1 kc/sec. A Faraday cup collects the ions which have acquired sufficient energy to overcome the plasma potential. When the current from the Faraday cup reaches a threshold level, the oscilloscope trace of the saw-tooth wave form is intensity-modulated, producing the desired plasma potential vs time relation. (auth)

15344 (UCRL-7549-T) TEST AND EVALUATION OF LARGE MAGNETIC TAPE-WOUND CORES USED IN THE ASTRON ACCELERATOR. Roger L. Sewell (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 15, 1963. Contract W-7405-eng-48. 22p. (CONF-404-1)

For Presentation at International Conference on Non-Linear Magnetics, Washington, D. C., Apr. 1964.

The 333 cores are tape-wound toroids of Fe–Ni. Each core is required to support 16 kgauss for 0.4 μsec. The results of tests of the cores at this rating with a 250-Mw, 1-ohm source are presented as B-H and impedance and Δμ vs time plots. The measurement techniques and subsequent data reduction are also described. External coatings were found to increase the mechanical strength of the cores without affecting magnetic properties. Lamination insulation was also developed and tested. (D.C.W.)

15345 (USCEC-82-208) THE KINETIC THEORY OF WAVES IN A WARM PLASMA EXCITED BY A CURRENT SOURCE. Hans H. Kuehl (University of Southern California, Los Angeles. Engineering Center). Dec. 1962. Contract AF19(604)-6195. 20p. (AFCRL-62-970)

The general expression for the electromagnetic field due to an arbitrary monochromatic current source in an unbounded, warm, homogeneous plasma in the absence of a magnetostatic field is derived. The linearized Boltzmann equation with a simple relaxation collision term is used, and the ion motion is neglected. The result is specialized to the case of an electric dipole source, which is compared to the result obtained from the hydrodynamic equations. It is found that, except for Landau damping, the two methods agree provided the frequency of the dipole is near the plasma frequency. (auth)

15346 (AEC-tr-5474) ON THE REASONS FOR ANOMALOUS LOSS OF ELECTRONS OUT OF THE OGRA PLASMA. Yu. A. Kucheryaev and D. A. Panov (Akademiya Nauk S.S.S.R. Institut Atomnoi Energii). Translated by J. Lewin (Oak Ridge National Lab., Tenn.), from Preprint No. 23/235. 1962. 21p.

It was previously discovered that the plasma in OGRA acquires an anomalously large positive charge. This potential difference between the plasma and the walls reaches several tens of kilovolts. Experiments were run to determine the acquisition of longitudinal energy by electrons. The experiments showed that electrons having an initial energy of about 1 kv acquire an energy spectrum in one pass through the plasma that reaches several hundred ev; that is, the spread of energy reaches several hundred ev. An analysis of the oscillations of the electron beam current showed that the energy of the electrons is affected by oscillating longitudinal electric fields that arise because of the cyclotron instabilities of the plasma. (auth)

15347 (AEC-tr-5804) INVESTIGATIONS OF PLASMA IN OGRA. G. F. Bogdanov. Translated by J. Lewin (Oak Ridge National Lab., Tenn.), from Russian. 1962. 39p.

Measurements in OGRA revealed the development of flute instabilities and an electrostatic (cyclotron) instability. A positive potential impressed on the end grids completely suppressed the flute instability and decreased the cyclotron instability. Anomalously rapid heating of electrons leading to escape was established, together with a possible relation between electron heating and the cyclotron instability. Substantial escape of atomic and molecular ions through the mirrors was also detected. Further, the energy spectrum of fast ions leaving through the mirrors was found to have an anomalously wide spread. Evaluation of the partial densities of atomic and molecular ions indicates that in plasma stabilized by end grids the loss of atomic ions exceeds by 2 or 3 times the losses due to charge exchange with residual gas. The mechanisms for some of these effects and processes were established. (D.C.W.)

15348 (JPRS-23436(p.87-98)) ELECTRODYNAMIC PROPERTIES OF A NON-STATIONARY PLASMA. V. N. Lugovoi (Lugovoy). Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 6: 695-701(1963).

The electric conductivity tensor for a nonrelativistic plasma in a time-periodic strong extraneous electromagnetic field is calculated. It is assumed that the extraneous magnetic field has an a-c component parallel to the d-c component. Examination of the local absorption indicates that paramagnetic amplification of electromagnetic waves in such a plasma is impossible. (auth)

15349 (JPRS-23436(p.99-111)) COLLISION INTEGRAL FOR A PLASMA. V. P. Silin. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 6: 702-8(1963).

A collision integral for plasma particles is obtained that takes into account both the Coulomb and transverse interactions of the particles. The effect of the transverse interaction on diffusion across a magnetic field in an electron-positron plasma is investigated. A general expression is obtained for the diffusion coefficient. For the case of a rarefied plasma, the dependence of the diffusion coefficient on the direction of the electromagnetic fluctuation radiation is determined. (auth)

15350 (JPRS-23436(p.112-23)) ELECTROMAGNETIC WAVES IN AN INHOMOGENEOUS MEDIUM PIERCED BY A PLASMA BEAM. V. Ya. Eydman. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 6: 709-14(1963).

The propagation of longitudinal waves in a stratified inhomogeneous medium pierced by a homogeneous plasma beam was studied. It was shown that the inhomogeneity of the medium can lead to a radical change in the stability of the system. Thus, if instability is realized in a homoge-

neous medium, consideration of the dependence of the dielectric constant on the coordinates may result in stability for the system. (auth)

15351 (JPRS-23436(p.136-50)) RESONANT RADIATION OF A CHARGE MOVING NEAR A PLASMOID. G. V. Gorodinskii (Gorodinskiy) and V. V. Tamoykin. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 6: 721-8(1963).

The radiation of a charge moving uniformly over a spheric plasmoid is investigated in the approximation $k \ll 1$ ($k \omega/c$). It is shown that at frequencies corresponding to dipole, quadrupole, and higher multipole resonances, a resonant radiation appears, the intensity of which greatly exceeds the energy radiated by the charge moving over a metallic sphere of the same dimensions. (auth)

15352 (JPRS-23436(p.372-7)) RADIATION FRICTION DECELERATION OF A CHARGE MOVING IN A PLASMA SITUATED IN A MAGNETIC FIELD. E. (Ye.) G. Larionstsev and V. D. Shafranov. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 6: 850-2(1963).

A general expression for the work done by the radiation friction force on the translational and rotational degrees of freedom of a charge is obtained in a form that permits direct quantum interpretation. (auth)

15353 (JPRS-23436(p.378-80)) CONCERNING THE DAMPING OF ELECTROMAGNETIC WAVES IN A PLASMA PLACED IN AN INHOMOGENEOUS DIELECTRIC. V. Ya. Eydman. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 6: 852-3(1963).

The propagation of a plasma wave in a layered inhomogeneous medium with slowly varying properties is considered. Damping of the wave is shown to be due to the transition radiation. (D.C.W.)

15354 PERTURBATION OF THE ELECTRICAL DISCHARGE IN A UNIFORM, THERMIONIC PLASMA DUE TO A VISCOUS BOUNDARY LAYER. W. Daellenbach (Battelle Memorial Inst., Geneva). Advan. Energy Conversion, 3: 647-56(Oct.-Dec. 1963).

The influence of the viscous boundary layer on the electrical discharge in the channel of an MHD generator is investigated. It is found that the additive voltage necessary to maintain the electrical current density due to the boundary layer is small under typical conditions encountered in MHD generators. It is concluded that the influence of the viscous layer is small compared with that of the ohmic resistivity of the non-viscous part of the plasma flow. (auth)

15355 DATA PROCESSING SYSTEM FOR THE AUTOMATIC TRANSFORMATION OF OBSERVED PLASMA INTENSITIES INTO THEIR RADIAL DISTRIBUTION. D. R. Paquette and W. L. Wiese (National Bureau of Standards, Washington, D. C.). Appl. Optics, 3: 291-6(Feb. 1964).

A data recording and processing system is described that automatically unfolds the observed side-on radiation from cylindrically and rotationally symmetric plasmas into the radial distribution. The projected intensity profiles over a cross section of the source are photoelectrically detected and integrated over small intervals of equal length utilizing a voltage-to-frequency converter. The output is fed into a digital counter and recorded on paper tape together with auxiliary information. The data are then processed by an electronic computer using an available transformation scheme which utilizes the Abel integral equation. In comparison to manual processing the precision is vastly improved and surpasses by far the usual requirements of spectroscopic experiments. (auth)

15356 RF COUPLING TO AN ELECTRON BEAM THROUGH A PLASMA. M. A. Allen, C. S. Biechler, and H. S. Maddix (Microwave Associates, Inc., Burlington, Mass.). Appl. Phys. Letters, 4: 107-8(Mar. 15, 1964).

R-f coupling to an electron beam passing through a plasma is investigated for the purpose of increasing the upper limits on output power and frequency of linear microwave tubes. Experiments performed in the 3-Bc range using a resonant plasma between a metal output waveguide and the beam indicate that resonant plasmas can be used as input and output circuits for microwave tubes, allowing the full benefit to be derived from the replacement of metal cavities and circuits by plasma. (C.E.S.)

15357 ACOUSTIC RESONANCES IN AFTERGLOW PLASMAS. Hans J. Schmitt (Sperry Rand Research Center, Sudbury, Mass.). Appl. Phys. Letters, 4: 111-12(Mar. 15, 1964).

Resonances were observed in late afterglow plasmas where the electron temperature and density profile could be accurately predicted so that resonance frequencies could be correlated with computed values. Observations were made for various fixed frequencies from 10 to 2000 Mc in gases of Ne, Ar, He, and Hg. (C.E.S.)

15358 ON THE INTERNAL ELECTROMAGNETIC ENERGY IN A PLASMA. O. Holter and S. Tjoetta (Univ. of Bergen, Oslo). Arbok Univ. Bergen, Mat.-Nat. Ser., No. 6, 15p.(1962).

A review is given of the electromagnetic energy containment and transport for wave propagation in a plasma. Gradients in pressure and temperature are neglected, and the current density is assumed to be a linear function of the electric field only. The thermodynamics of the plasma is briefly discussed. For the case of small frequency ranges of a variable electromagnetic field the energy density is derived. In this case the energy can be given an interpretation as thermodynamical internal energy. A formal treatment of the plasma as a dielectric medium leads to the expression for the electromagnetic energy first obtained by Brillouin and recently discussed by several authors. The mean energy density is shown to be the factor of proportionality between the mean Poynting vector and the group velocity. As an example the internal energy is calculated for waves in a zero temperature plasma in an external magnetic field. The slow and the rapid build up of the field to a final steady state, in which the plasma has a drift velocity, is also discussed briefly. (auth)

15359 ON THE SOLUTIONS OF LINEARIZED EQUATIONS OF MAGNETOHYDRODYNAMICS IN NONHOMOGENEOUS MAGNETIC FIELDS. E. Infeld (Inst. for Nuclear Research, Warsaw). Bull. Acad. Polon. Sci., Sér. Sci., Math., Astron. Phys., 11: 707-13(1963).

It is shown that Alfvén-type solutions of the linearized equations of magnetohydrodynamics are exact under certain conditions, and that the Alfvén-type waves are not diminished in flat fields. Solutions are given for chosen fields. (R.E.U.)

15360 NONLINEAR PROPAGATION OF ELECTROMAGNETIC WAVES IN MAGNETOPLASMAS. [PART] II. Mahendra S. Sodha and Carl J. Palumbo (Republic Aviation Corp., Farmingdale, N. Y.). Can. J. Phys , 42: 349-63 (Feb. 1964).

The nonlinear propagation of an electromagnetic wave at an arbitrary angle to the direction of the magnetic field in

a plasma was studied. An expression is derived for the complex conductivity tensor of a Lorentzian magnetoplasma, which is correct to terms involving the square of the amplitude of the electric vector. This expression, along with the wave equation, was used to analyze two specific problems; the propagation of an electromagnetic wave in an infinite magnetoplasma, and reflection and refraction at the interface of a nonlinear magnetoplasma and a linear isotope medium. (auth)

15361 RELAXATION TIME AND SOLUTION OF GUERNSEY-BALESCU EQUATION FOR HOMOGENEOUS PLASMAS. R. L. Rosenberg and Ta-You Wu (National Research Council, Ottawa). Can. J. Phys., 42: 548-62 (Mar. 1964). (NRC-7744)

The kinetic equation of Guernsey-Balescu for spatially homogeneous plasmas is solved as an initial value problem in the linearized approximation. The distribution functions F_1 for the electrons and the positive ions are expanded in series of associated Laguerre polynomials in the momentum, with coefficients that are functions of the time. The solution of the (infinite) systems of linear equations for these coefficients leads to the "spectrum of relaxation times." The damping constants vary from 10^{-4} to O(1) in units of $(v/rD^3)\omega$, where v is the "volume per particle," rD is the Debye length, and ω is the plasma frequency of the electrons $\omega^2 = 4\pi e^2/vm$. Numerical results are given for a few finite numbers of terms in the expansions of F_1. For a homogeneous plasma with a given initial velocity distribution, the asymptotic approach, after an initial rapid damping, to the Maxwellian distribution has a relaxation time of the order $10^4(rD^3/v\omega)$. The results and the question of the appropriateness, in the case of ionized gases, of the use of the Bogoliubov "initial condition" and "functional Ansatz" in the formulation of a theory of irreversible processes are discussed. (auth)

15362 EXPERIMENTAL STUDY OF THE SINUSOIDAL FORCED OSCILLATIONS OF AN ELECTROCONDUCTIVE LIQUID IN A RIGHT-ANGLE RECTILINEAR TUBE IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. René Causse, Étienne Crausse, Yves Poirier, and Charles Vivès (Faculté des Sciences, Algiers). Compt. Rend., 258: 1399-1401(Feb. 3, 1964). (In French)

An experimental study was made of the sinusoidal and forced oscillations in a right-angle rectilinear tube of an electroconductive viscous liquid exposed to a uniform magnetic field perpendicular to the flow. Curves showing the variations of the maximum mean velocity and the phase difference for various values of the fundamental parameters are given. (tr-auth)

15363 INDUCED RESONANCE SCATTERING AND RADIATION IN MATTER. V. N. Tsytovich (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR, 154: 76-9 (Jan. 1, 1964). (In Russian)

Cherenkov radiation emission and absorption can be used to describe non-linear effects in plasmas. Perturbation theory cannot be used to describe the induced scattering, emission, and absorption of radiation if the frequency and angle of the radiation is near the Cherenkov cone $\omega = \mathbf{k}\cdot\mathbf{v}$. Resonance scattering takes place because of the possibility of spontaneous emission and absorption of Cherenkov radiation. A consideration of the resonance effects leads to a radiation correction to the Green's function for the charged particles in the plasma. Equations are presented that describe the resonance effects and that use the standard methods of quantum electrodynamics. In general the averaged plasma effects do not have a resonant character, and the resonance effects can be neglected if the wave momentum $p \ll eA$, where A is the vector potential of the wave. (TTT)

15364 MAGNETOACOUSTIC RESONANCE AND DECAY OF A PLASMA. Edgar Cantieni and Helmut Schneider (Universität, Freiburg i. B.). Helv. Phys. Acta, 36: 993-1020(1963). (In German)

An experimental and theoretical investigation was made of the magnetoacoustic resonance in a cylindrical argon plasma. The plasma, which was immersed in an axial magnetic field, was generated by a discharge current and was highly ionized. The wave was excited at the plasma boundary by an auxiliary B_z-coil and traveled radially to the center of the cylinder. Linearized theory was used to obtain the solution for the general case of partial ionization. The solutions for resonance curves and radial distribution of the wave magnetic field are presented with the degree of ionization as a parameter. Measurements are shown to be in good agreement with theory. It is shown that magnetoacoustic resonance can be used as a diagnostic method for determination of the ion density of a partially ionized plasma. Densities measured spectroscopically from Stark broadening of the H_δ line were in agreement with densities measured with magnetoacoustic resonance within the errors. The decay of the ion density, which followed the cooling of the plasma, is discussed. (auth)

15365 TEMPERATURE EFFECT ON LANGMUIR PROBE MEASUREMENT. Che Jen Chen (California Inst. of Tech., Pasadena). J. Appl. Phys., 35: 1130-3(Apr. 1964).

A substantial lowering of the work function of a tungsten Langmuir probe immersed in an argon plasma in a discharge tube is observed. The mechanism is thought to be similar to the Schottky effect. The electron temperature measurement is lowered about 30%, in a particular discharge condition, as the probe goes from room temperature to 2000°C. The charge number density measurement by saturation electron current appears to be higher by 15%, and that by ion saturation current appears to be higher by almost one order of magnitude. This phenomenon can also account for the discrepancy of the ratio of ion and electron saturation current. (auth)

15366 BACKSCATTER OF ELECTROMAGNETIC RADIATION FROM A TURBULENT PLASMA. E. E. Salpeter (Cornell Univ., Ithaca, N. Y.) and S. B. Treiman. J. Geophys. Res., 69: 869-81(Mar. 1, 1964).

Any attempt at a quantitative description of the scattering of electromagnetic radiation from a turbulent plasma medium is bound to involve physical and mathematical approximations. The appropriateness of alternative approximation schemes is governed by a variety of parameters that characterize the radiation, the scattering geometry, and the structure of the plasma, e.g., the radar wavelength and angle of incidence, the mean electron density, the correlation function for electron density fluctuations, etc. A semiquantitative classification of the various regimes is presented, and corresponding approximation schemes appropriate for each are described and assessed. For a sufficiently underdense plasma a natural first estimate is represented by the Born approximation for scattering from turbulent eddies. In this approximation the scattering is a volume effect, independent of geometry; but the limits on the validity of the Born approximation and the nature of the next-order corrections are determined by geometry, multiple scattering, and other effects which are discussed at some length. At the opposite extreme, for a sufficiently

overdense plasma, the scattering is produced by surface fluctuations. This regime is discussed in some detail, and parameterization schemes are described. Throughout the entire discussion only the case of net radar scattering through very large angles, in fact, with the cross section for backscattering is considered. Collision damping is ignored. For every regime particular attention is devoted to the dependence of the backscatter cross section on the angle of incidence of radar beam with respect to the surface of the plasma medium. (auth)

15367 THE STABILITY OF LINEAR PINCH AND HARD-CORE DISCHARGES. K. L. Aitken, R. J. Bickerton, P. Ginot, R. A. Hardcastle, A. Malein, and P. Reynolds (Culham Lab., Abingdon, Berks, Eng.). J. Nucl. Energy, Pt. C., 6: 39-69(Jan.-Feb. 1964).

Measurements are described of the behavior of 100 to 200 kamp discharges in a variety of configurations of the general pinch and hard-core type. The systems were studied using a variety of internal and external magnetic probes, by electrostatic double probes, and by fast photography. Correlation of the magnetic field fluctuations measured by the various coils enabled the axial wave number k and azimuthal mode number m of the perturbation to be deduced. In both pinch and hard-core cases the predominant mode number was m = 1 and the sign and magnitude of k were such that the perturbation was helical with a direction parallel to that of the mean magnetic field. Framing camera pictures of the discharge supported these results. Increasing the azimuthal magnetic field at all radii in the hard-core case was found to reduce the amplitude of the magnetic fluctuations, and a discharge stable on this basis was achieved. By contrast, increasing the axial field at all radii had a slight de-stabilizing effect. Programming the axial field so as to have a null at some radius made the discharge violently unstable. Electric field measurements in stable and unstable hard-core discharges showed irreproducible fluctuations in the latter case of ~10 v/cm and frequencies 500 kc/s to 1 Mc/s. Langmuir probe measurements of the plasma density in pinch and hard-core discharges showed a well-confined plasma only in the hard-core case. The results are shown to be in good agreement with the theory of hydromagnetic stability when, and only when, the effect of finite electric conductivity is included. (auth)

15368 RESONANT BEHAVIOR OF A HOLLOW CYLINDRICAL PLASMA. II. ASYMMETRY EFFECTS. J. Nucl. Energy, Pt. C, 6: 71-9(Jan.-Feb. 1964).

It was previously demonstrated theoretically and experimentally that a hollow cylindrical plasma possesses two main resonance frequencies. When the two cylinders limiting the plasma are not centered on the same axes, it is shown theoretically that each resonance splits into a couple of cross-polarized resonances. These results are in very good agreement with the experimental data. (auth)

15369 ON MAGNETIC TRAPS. J. D. Jukes (Culham Lab., Abingdon, Berks, Eng.). J. Nucl. Energy, Pt. C, 6: 84(Jan.-Feb. 1964).

It is proved that given a force-free or vacuum field in which field lines envelop a closed flux surface F enclosing finite volume, there exists a region on F where field strength increases inwards across F. (R.E.U.)

15370 MEASUREMENT OF SPATIAL DISTRIBUTION OF ELECTRON DENSITY IN A PLASMA BY MICROWAVE FREE SPACE METHOD. Syoichi Miyoshi, Yuichi Sakamoto, and Kyoko Matsuda (Inst. of Physical and Chemical Research, Tokyo). Japan J. Appl. Phys., 3: 18-23(Jan. 1964).

A measurement of the spatial distribution of the electron density in a plasma was carried out. The electron density of the plasma axis was determined by the microwave radiation from the plasma. This procedure was applicable for the plasma column whose diameter was comparable with a wavelength. The plasma studied was a positive column whose diameter was about 8 cm, in helium at pressure of 0.7 mm Hg. A microwave interferometer was used in K-band and the receiver for microwave radiation in X-band. Experimental results obtained by the microwave method were compared with those by the Langmuir probe method, and a satisfactory agreement between the two results was obtained. (auth)

15371 CESIUM AND POTASSIUM PLASMA EXPERIMENTS. Nicola D'Angelo (Institut für Plasmaphysik, Garching, Ger.). Nucl. Fusion, 3: 147-53(Sept. 1963).

Experiments performed on cesium and potassium thermal plasmas produced by thermal ionization of neutral atoms on tungsten and tantalum surfaces are reviewed. A description of typical cesium or potassium thermal-plasma devices is given. Actual experiments are dealt with, as follows: Experiments on plasma diffusion across a magnetic field. In these experiments it is found that when no current is passed through the plasma, diffusion proceeds according to the predictions of the "classical" theory ($D_\perp \approx 1/B^2$). The magnitudes of the diffusion coefficients are also in agreement with the results of classical theory based on ion-electron collisions. Excitation and propagation of low-frequency waves. Three different experiments are described. The first deals with ion waves excited by passage of a small current along the magnetic lines over a very small part of the plasma cross section. The frequency of the oscillations is generally slightly in excess of the ion cyclotron frequency, and the waves are electrostatic ion waves propagating almost at a right angle to the magnetic lines. The second experiment deals with ion waves propagating in the azimuthal direction across the magnetic lines and the radial density gradients of the plasma column. The phase velocity of these waves has the same magnitude as the ion macroscopic velocity of the zero-order motion. The third experiment deals with excitation, propagation along the magnetic lines and damping of ion acoustic waves. The phase velocity and the damping of the waves have been measured. In particular, the wave attenuation appears to be explainable only in terms of collisionless (Landau) damping. Spectroscopy experiments. A brief description is given of a spectroscopic determination of the recombination coefficient in cesium. Beam-plasma interaction. The effect of this interaction on the amplification of a microwave signal applied as a modulation to an electron beam that passes through a 2.2-cm length of cesium plasma is discussed. Considerations about experiments that appear feasible with alkali-metal plasma devices, some of which are under way, are discussed. In particular, the production of a cesium plasma in a stellarator geometry is considered. (auth)

15372 PROPAGATION OF ION-CYCLOTRON PLASMA WAVES IN A WEAK INHOMOGENEOUS FIELD. K. N. Stepanov (Kharkov Inst. of Physics and Tech.). Nucl. Fusion, 3: 154-9(Sept. 1963). (In Russian)

Propagation of ion-cyclotron waves along a plasma cylinder in a longitudinal magnetic field that slowly changes along the cylinder axis is discussed. An integrodifferential equation has been obtained for the electric-wave field, and the solution has been found for this equation in a geometrical-optics approximation. (auth)

15373 THEORY OF BETATRONIC ELECTRON ACCELERATION IN AN AZIMUTHAL PINCH AS A FUNCTION OF INITIAL CONDITIONS: COMPARISON OF EXPERIMENTAL RESULTS. L. Dupas, J. Leroy, and T. Consoli (Centre d'Etudes Nucléaires, Saclay, France). Nucl. Fusion, 3: 160-73(Sept. 1963). (In French)

In the course of a more general study on the influence of initial plasma conditions on plasma evolution under magnetic compression it was decided to analyze the mechanism responsible for the production of gamma rays observed and measured while the compression field was being set up. In the first part we tried to measure the time of diffusion and the depth of penetration of the electric field induced by variation of the compression field. It was found that the diffusion of this azimuthal electric field in the column of plasma produced by reflex discharge is quasi-complete and instantaneous. From the very commencement of compression, therefore, there exist two crossed fields (B_0 static initial and E_θ azimuthal induced), and the presence of these fields is a necessary and sufficient condition for the acceleration of electrons in a transverse plane. This layer of quasi-relativistic electrons produced through improved conductivity makes it possible to trap the static magnetic field existing at the moment of their formation. The equations of motion are solved, starting from the initial conditions of experimental physical reality. The theoretical energies obtained by this mechanism are in agreement with the energy of the measured gammas. Experimental results of gamma-ray and uhf-radiation measurements and photographic recordings are given. (auth)

15374 TOPOLOGY OF STEADY-STATE PLASMA CONFIGURATIONS IN TRANSVERSE SELF-CONSISTENT FIELDS: SPATIAL-PERIODIC PLASMA STRUCTURES: [PART] I. N. N. Komarov. Nucl. Fusion, 3: 174-82 (Sept. 1963). (In Russian)

Neglecting collisions, we consider a kinetic approximation for the Boltzmann function of particle distribution with a longitudinal macroscopic velocity that does not depend on the coordinates. With it we solve the two-dimensional problem of the equilibrium configurations of an l-component plasma in self-consistent internal and external transverse magnetic fields (and also in electric fields caused by a non-compensation of plasma charge as a whole). The solution obtained with the given assumptions is a general one and permits one to make a broad analysis of equilibrium plasma configurations with longitudinal currents in self-consistent external and internal transverse fields. It is shown that existence of steady plasma states with a spatial-periodic structure is possible. This corresponds to the data of experiments in which it has been reliably established that a plasma arising in pinch discharges has a fibrous structure characterized by a definite space periodicity. (auth)

15375 EQUILIBRIUM OF A SMALL TOROIDAL PLASMA COLUMN WITH AN ARBITRARY CURRENT DISTRIBUTION ALONG THE CROSS SECTION. V. D. Shafranov (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 3: 183-9(Sept. 1963). (In Russian)

Transverse (meridional) cross sections of magnetic surfaces in a toroidal plasma column are circles with displaced centers in the first-approximation expansion in ratio of the column radius ρ to the torus radius R. In the cross section of every magnetic surface a polar coordinate system of its own can be introduced (with the origin on the center of this cross section), in which the transverse magnetic field on a given magnetic surface has an azimuthal component only. The "asymmetry coefficient" $\Lambda(\rho)$ of the azimuthal field that is introduced thus for every toroidal magnetic surface is an important characteristic of the toroidal equilibrium configuration. It is shown that the distance $\Delta(\rho)$ between the centers of the cross sections of two magnetic surfaces is expressed by a simple formula in $\Lambda(\rho)$. The toroidal corrections to plasma pressure and magnetic field are easily expressed in terms of $\Delta(\rho)$. In a fixed coordinate system (ω,ρ) the origin of which coincides with the center of the cross section of radius a_1 of some "initial" magnetic surface, the correction to the transverse magnetic field can be expressed. The expression $\Lambda(\rho)$ is obtained for a tubular (levitron-type) plasma column and for a continuous plasma column. Some examples of the calculation of toroidal corrections are given. (auth)

15376 OSCILLATIONS OF A DILUTE PLASMA WITH AN ARBITRARY DEGREE OF INHOMOGENEITY. V. V. Arsenin (Inst. of Engineering and Physics, Moscow). Nucl. Fusion, 3: 190-6(Sept. 1963). (In Russian)

Neglecting collisions, an operator is found for the dielectric permeability tensor of a rarified, inhomogeneous plasma in a magnetic field. The initial set of equations consists of kinetic equations with a self-consistent field for electrons and ions and Maxwell's equations for an electromagnetic field. Neglecting magnetic-field inhomogeneity, the unperturbed distribution function is chosen as a product of Maxwell's function and the arbitrary function from the position of the center of the Larmor circle described by a particle in a plane perpendicular to the magnetic field. In contrast to the usual setup of the problem, no limitation is imposed on the smallness of unperturbed density gradients so that the characteristic dimension of inhomogeneity can be compared to the Larmor radii of the particles. The equations obtained for electromagnetic-wave distribution in inhomogeneous plasma represent a system of integral equations for the Fourier components of the electric field. These equations are investigated in simple cases. Both an ordinary wave propagating across a magnetic field and potential perturbations have been examined. (auth)

15377 PLASMA DENSITY MEASUREMENTS WITH A MOLECULAR BEAM. R. J. Kerr (Oak Ridge National Lab., Tenn.). Nucl. Fusion, 3: 197-204(Sept. 1963).

Investigations of high-energy plasma require probing techniques that do not change the plasma characteristics. A molecular beam is such a probe for plasmas that have energetic electrons and cold ions. Attenuation of the beam is mainly by electron ionization, but other single-particle processes must be considered. A beam of hydrogen molecules is used as the probe. That portion of the neutral beam that passes through the plasma is measured as a pressure by a specially designed differential manometer. The measured attenuation is then used to calculate plasma density using known values of the cross sections for the interactions between beam molecules and plasma electrons and ions. (auth)

15378 THEORY OF HIGH-FREQUENCY HEATING OF AN INHOMOGENEOUS HIGH-TEMPERATURE PLASMA. V. V. Dolgopolov and K. N. Stepanov (Khar'kov Inst. of Physics and Tech.). Nucl. Fusion, 3: 205-7(Sept. 1963). (In Russian)

Cherenkov absorption by a plasma of the energy of an electromagnetic field created by azimuthal electric currents flowing in a long coil around a plasma cylinder is studied. The density of external currents has the form of a traveling wave. The frequency of the field is considerably

smaller than the ion cyclotron frequency. Gas-kinetic plasma pressure is assumed small compared with the magnetic pressure. Plasma density, electron temperature, and ion temperature are taken to be functions of the radius. Expressions have been found for the energy absorbed by plasma per unit time. Absorption is maximal when the phase velocity of the wave is of the order of the thermal velocity of the ions. For a strongly non-isothermal plasma, heating increases drastically if the phase velocity of the wave is near the velocity of sound in a collisionless plasma. Expressions have also been obtained for energy absorbed by an inhomogeneous plasma for coils of finite lengths. (auth)

15379 INTERACTION BETWEEN AN ELECTROMAGNETIC WAVE AND A BOUNDED PLASMA. E. P. Fetisov (Lebedev Inst. of Physics, Moscow). Nucl. Fusion, 3: 208-14(Sept. 1963). (In Russian)

Reflection and absorption of an electromagnetic wave by a bounded plasma are studied. Inevitably in considering spatial dispersion, the necessity arises to formulate an additional boundary condition. In macroscopic discussion such conditions must be postulated, but this cannot be regarded as satisfactory. The microscopic approach, using the kinetic equation method, transfers the center of gravity of the problem to the model of the boundary. But the ordinarily used formal conditions of the so-called "specular" or "diffuse" reflection of electrons of the medium from the surface do not permit elucidation of the physical conditions to which they correspond. The case of a magnetic field in one half of space only and the impingement on a plasma of an electromagnetic wave polarized both along the stationary magnetic field and transverse to it are discussed. The problem is formulated and boundary properties are determined. In agreement with the boundary model, there is the unperturbed distribution function and a stationary magnetic field. It is assumed that plasma pressure is small compared to magnetic pressure. An attempt is made to find the non-equilibrium addition to the distribution function caused by the impinging electromagnetic wave. The presence of regions with different properties leads to the fact that the condition of periodicity of the distribution function in azimuthal angle is insufficient for this problem. The particular case of polarization of an impinging wave, when the electric vector is parallel to the stationary magnetic field, is studied. In the region of frequencies that correspond to a weak space dispersion, general expressions have been written for the fields, and the reflection and absorption coefficients have been obtained. Within the limits of the conventional approximation, energy absorption does not depend on the magnetic field. Finally, the oblique impingement of an electric-vector wave that is perpendicular to the stationary magnetic field is studied. In this case energy losses arise that depend on the magnetic field and also losses due to the excitation of a longitudinal electromagnetic plasma wave. On the grounds of the study performed, it can be concluded that with an increase of the magnetic field, the boundary, with respect to its reflecting and absorbing properties, approaches a mirror boundary. This enables one to talk of a universal boundary condition. This work indicates the limits of applicability of the universal condition in different problems. (auth)

15380 OBSERVATIONS OF RESISTIVE INSTABILITIES IN A THETA PINCH. H. A. B. Bodin (Culham Lab., Berks, Eng.). Nucl. Fusion, 3: 215-17(Sept. 1963).

Framing and streak-camera photography is used to detect the breakup of a reversed-field pinch plasma into randomly distributed, discrete rings. The subsequent motion of these rings is studied. The properties of the rings suggest that they have their origin in a resistive instability. (T.F.H.)

15381 PLASMA INSTABILITIES DUE TO RESISTIVITY GRADIENTS. B. Coppi (Stanford Univ., Calif.). Phys. Letters, 8: 169-70(Feb. 1, 1964).

A mode of growth of instabilities in a resistive sheet pinch due to a resistivity gradient at the singular surface is found analytically using a new ordering for the perturbed and unperturbed equilibrium quantities. (R.E.U.)

15382 SCATTERING OF LIGHT FROM THE ELECTRONS IN A PLASMA. W. E. R. Davies and S. A. Ramsden (National Research Council, Ottawa). Phys. Letters, 8: 179-80(Feb. 1, 1964).

The density and velocity distribution of electrons in a plasma were studied by Thomson scattering of light from a ruby laser incident on a θ-pinched plasma. (R.E.U.)

15383 DYNAMICS OF DEGENERATE ELECTRON GAS IN A MAGNETIC FIELD. Amiram Ron (Univ. of California, San Diego, La Jolla). Phys. Rev., 134: A70-9 (Apr. 6, 1964).

Some aspects of the correlations between interacting electrons in a magnetic field are studied by a quantum kinetic approach, taking into account the quantization of the orbital motion of the electrons. The treatment is based on the introduction of an hierarchy of equations of motion for the s-body density matrices and employing a decoupling scheme, valid in the self-consistent field approximation. In this way the dielectric function is introduced "naturally," and the response of the system to an applied field is calculated. The dielectric function reflects the two main effects of the correlations, i.e., the collective excitations of the system and the dynamical shielding. The dielectric function plays a role also in the "dressing" of the interacting electrons. This is shown by calculating the spectrum of the density fluctuations and the equation that governs the approach to equilibrium of the system. The method is not limited to systems in thermal equilibrium, but also applies to systems in other stationary equilibrium states. (auth)

15384 AMBIPOLAR DIFFUSION IN AN ISOTHERMAL OXYGEN PLASMA AT ELEVATED TEMPERATURES. Michael H. Mentzoni (Sylvania Electronic Systems, Waltham, Mass.). Phys. Rev. 134: A80-5(Apr. 6, 1964).

Electron removal in an afterglow discharge in oxygen was measured using microwave diagnostic techniques. For pressures below 1 mm Hg it was found that ambipolar diffusion was the principal loss process in the late afterglow that, by microwave radiation temperature measurements, was proven to be isothermal at the ambient gas temperature. A marked difference in the rate of diffusion for the low- and high-current discharge afterglow at room temperature was demonstrated with $D_a p$ values equal to 110 ± 10 and 216 ± 20 cm^2 sec^{-1}, respectively. The identity of the ions leading to the higher value is not well established since it is not clear how O^+ ions could be predominant in the high-current case. It is perhaps more probable that the ion O_3^+ is responsible based on some reported mass spectrometric studies of the oxygen afterflow. The ions responsible for the lower $D_a p$ value, however, are most probably O_2^+ judging from previously published results. These ions display a strongly temperature-dependent diffusion rate in the range 300 to 900°K that on the mobility

versus temperature plot, resulted in a maximum of about 5.0 cm^2 sec^{-1} V^{-1} around 600°K after a steep climb from the value 2.8 cm^2 sec^{-1} V^{-1} at T = 300°K; between 600 and 900°K the decline in mobility is only slight. This behavior is discussed in terms of ion-molecule force fields and charge transfer. (auth)

15385 REMARK ON THE PLASMA EQUATION OF STATE. H. Wergeland (Instut for Teoretisk Fysik, Trondheim, Norway). Proc. Phys. Seminar Trondheim, No. 2, 5p.(1964).

A simple form of the plasma equation of state is derived, under the assumption of applicability of the Debye-Hückel approximation. (T.F.H.)

15386 HIGH CURRENT ACCELERATORS IN NUCLEAR PHYSICS. Jerry B. Marion (Univ. of Maryland, College Park). Proc. Symp. High Power Accelerator Appl., New York, 1961, 21-7(1962).

The uses of high-current positive-ion accelerators for low-cross-section reactions are discussed. The use of low intrinsic efficiency detectors and the low counting rate for some experiments using the accelerator are discussed. The production of monoenergetic, variable-energy gamma rays in the nonresonance capture of protons by, e.g., oxygen-16 is discussed. (R.E.U.)

15387 ADDENDUM TO "A THEORY OF THE TURBULENT ELECTRIC FIELD FLUCTUATIONS IN ELECTRON PLASMAS. [PART] II." Takao Tsuda (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 30: 921-2(Dec. 1963).

An addendum to a previous paper (NSA 17: 7473) is presented that concerns frequency shifts due to an interaction hamiltonian. (R.E.U.)

15388 ON THE FOKKER-PLANCK EQUATION FOR COMPLETELY IONIZED PLASMA. Mircea Drăganu. Studia Univ. Babes-Bolyai, Ser. Math.-Phys., No. 1, 105-24(1963). (In Rumanian)

The general Fokker-Planck type equation established by Rosenbluth, MacDonald, and Judd for completely ionized plasma was expanded to spherical coordinates for space velocity assuming the absence of azimuthal symmetry. In special cases with azimuthal symmetry the developed equation coincides with the equation developed by Rosenbluth, MacDonald, and Judd for such a special case. In contrast, the relations between the h_a, g, and f_a functions are here deduced by a direct method without utilizing Fourier transforms, but using a Legendre polynomial series expansion of $|\vec{v}-\vec{v}'|$. The method has the advantage that it can be directly generalized to the absence of azimuthal symmetry. (R.V.J.)

15389 ON THE SOLUTION OF THE NONLINEAR VLASOV EQUATION. G. Knorr (Max-Planck-Institut für Physik und Astrophysik, Munich). Z. Naturforsch., 18a: 1304-15(Dec. 1963). (In German)

Wave-like equations of the nonlinear Vlasov equation for a one-dimensional electron plasma are discussed analytically and numerically. The quasilinear theory was derived in a simple way and some conclusions are drawn from it. It was found that, if the initial conditions of the harmonics of the electrical field differ by orders of magnitude, the type of the solution varies appreciably. The numerical solution was obtained by integrating the characteristic function of the distribution function f, i.e., it's Fourier transform in space and velocity. It is shown that this method is in principle superior to the direct integration of f. Stable and instable cases are discussed. Good agreement between theory and numerical computations was found. (auth)

15390 STATIONARY FLOWS OF CHEMICALLY REACTING GASES AND PLASMAS. W. Geiger (Technische Hochschule, Stuttgart). Z. Naturforsch., 18a: 1315-31(Dec. 1963). (In German)

Studies were made of the peculiarities that appear in the flow of chemically reacting gases and plasmas. The influence of chemical reactions on flow stability and on transitions in compression shocks were especially investigated. The stationary flow of reacting gases and plasmas had characteristic properties, which can be shown in an especially simple way for partly ionized hydrogen. For description of the phenomena, two different Mach numbers were introduced, which were derived from the sound velocity for high and low frequencies and were used alternately. By means of the two sound velocities and a further characteristic velocity the entire Mach number region was subdivided into individual regions, which are distinguishable especially by the behavior of flow opposite small disturbances. The theoretical investigation showed that in the region of the mean Mach number the shock transitions can be distributed in a principle shock, for which the influence of the reactions is essentially neglected, and a reaction zone behind the principle shock, which was also experimentally known. In the region of smaller Mach numbers, with Mach 1 as lower limit for relaxation-free equilibrium, with Mach 1 as upper limit for frozen equilibrium, a shock transition is possible, which is determined essentially alone by the dissipation mechanism of the chemical reaction. For very high Mach number, principle shocks and reaction regions were introduced no longer as separate zones. Here the dissipative mechanisms occurred simultaneously and the reaction equilibrium followed extremely fast. Typical cases were calculated. The stability of sonic and supersonic flow was investigated. The contribution of the reactions to entropy production in shock transitions was derived and its effects on the width of the compression shock are discussed. (tr-auth)

15391 MICROWAVE MEASUREMENTS IN T TUBES. H. Klingenberg (Ernst-Mach-Institut, Freiburg i.B.). Z. Naturforsch., 18a: 1331-8(Dec. 1963). (In German)

With a 3-cm microwave process the plasma front velocity and the relative range of the preionization and their dependence on pressure were measured in two T tubes, whose inner diameters were different by a factor of 4. The velocity measurements can be begun, on account of the disturbing influence of preionization, only after a pressure-dependent path distance of the plasma front. The power reflected from the plasma front can not be determined directly by this method. A comparison of the data ascertained for the two tubes showed a relation between the pressure, potential, and inner diameter of the T tubes, which allowed qualitatively comparable ratios for the two tubes to be prepared. From the relations equations were derived, which describe the dependence of plasma front velocity and the effects of preionization on the parameters. The experimental results speak for the correctness of the derived formulas. (tr-auth)

15392 ON NONLINEAR ENERGY LOSSES IN PLASMA CHARGE. S. B. Rubin and V. N. Tsytovich. Zh. Tekhn. Fiz., 34: 1-10(Jan. 1964). (In Russian)

Nonlinear energy losses were analyzed in hydrodynamic approximation at 0° temperature. A system of nonlinear equations was developed for charge motion in plasma. (R.V.J.)

15393 RADIATION OF IONS PASSING THROUGH A NONISOTHERMAL MAGNETO-ACTIVE PLASMA. V. I.

Pakhomov. Zh. Tekhn. Fiz., 34: 16-22(Jan. 1964). (In Russian)

Magneto-retarded and Cherenkov radiation intensities of ions moving along a spiral in a strongly nonisothermal plasma in a magnetic field were studied. (tr-auth)

15394 SPECTROSCOPIC MEASUREMENTS OF ION TEMPERATURE BY MEANS OF "TOKAMAK" DEVICE. V. G. Koloshnikov. Zh. Tekhn. Fiz., 34: 34-9(Jan. 1964). (In Russian)

Ion temperature and variations during discharge were measured using Doppler broadening. Measurements of D_β, C III, and He II, were made using the Tokamak installation. Oscillograms for various discharge times and temperatures are included. (R.V.J.)

15395 LEAKAGE OF CHARGED PARTICLES FROM A DISCHARGE WITH REFLECTED ELECTRONS. T. Ya. Fishkova, E. V. Shpak, and S. Ya. Yavor (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 53-9(Jan. 1964). (In Russian)

Leakage of charged particles across a magnetic field in a stationary discharge with reflected electrons was studied in a highly (more than 50%) ionized plasma pinch. Relations between anomalous currents, ion currents at wall probes, and magnetic fields were observed. (tr-auth)

15396 RESONANCE ELECTRON TRAPPING IN A MAGNETIC MIRROR WITH SPACE-PERIODIC HELICAL FIELD. R. A. Demirkhanov, Yu. V. Kursanov, D. G. Baratov, and G. V. Kharin. Zh. Tekhn. Fiz., 34: 60-5 (Jan. 1964). (In Russian)

Conditions for resonance trapping and retention times in a magnetic mirror with a space-periodic helical field were investigated. The helical magnetic field was excited by currents flowing in a winding consisting of three pairs of conductors. The resonance capture takes place at $\omega_c = \omega$ and $2\omega_c = \omega$. Under certain conditions injected electrons exceed 100 oscillations between probes. (R.V.J.)

15397 WEAKLY IONIZED PLASMA IN A JUNCTION DIODE. R. Ya. Kucherov and Yu. A. Shuander. Zh. Tekhn. Fiz., 34: 66-76(Jan. 1964). (In Russian)

Potential distribution in a junction diode filled with weakly ionized Knudsen plasma produced by thermo-emission and surface ionization on a cathode was investigated. A self-consistent solution was found for the problem of $\varphi_a = 0$ and $|e\varphi_a| \gg \theta$ (φ_a is anode potential, θ is plasma temperature) when there is only one extreme potential (a maximum). The case of a "shallow" potential well was also investigated. The results were used in an investigation of maximum potential distribution in boundary regions. (R.V.J.)

15398 DIFFUSION OF CHARGED PARTICLES OF DECAYING PLASMA IN A MAGNETIC FIELD. A. A. Ganichev, V. E. Golant, A. P. Zhilinskii, B. Z. Khotimskii, and V. N. Shilin (Leningrad Polytechnic Inst.). Zh. Tekhn. Fiz., 34: 77-88(Jan. 1964). (In Russian)

Decay of a weakly ionized plasma in a dielectric cylinder with a magnetic field distributed along the axis was studied using 0.4- to 7-cm diameter cylinders, 0.05 to 1.5 mm Hg helium pressures, and magnetic fields up to 6000 gauss. A super-high frequency resonator method was used for measuring charged particle concentrations in plasma decay. It was found that plasma decay obeys diffusion theory in 4- to 7-cm diameter, 70- to 80-cm cylinders. In 0.4- to 2-cm diameter cylinders the decay process is considerably faster than is predicted by diffusion theory as a result of particle collisions. (R.V.J.)

15399 ON THE CAUSES OF ABNORMALLY RAPID PLASMA DECAY IN MAGNETIC FIELD. A. I. Anisimov, V. N. Budnikov, N. I. Vinogradov, and V. E. Golant (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 89-92(Jan. 1964). (In Russian)

Previously it was found that as a result of collisions charged particle diffusion across a magnetic field is considerably larger than predicted by diffusion theory. Also, the coefficient is neither a function of pressure nor charged particle concentration. It was assumed that the discrepancy between experimental and theoretical magnitudes of the transverse diffusion coefficients may be caused by electron temperature deviations from the surrounding gas temperature (correlations were made at T_e = 300°K). Investigations were at various temperatures in order to estimate the electron temperature deviations. Experiments were also carried out to determine the time variability of charged particle and radiation intensities. The results indicate that the difference between the electron and surrounding temperatures cannot be considered a decisive factor in the discrepancy between theoretical and experimental transverse diffusion coefficients. Hence, it is postulated that the abnormally fast plasma decay in a magnetic field is caused by instability induced by oblique drift-wave oscillations. (R.V.J.)

15400 ON CYCLOTRON WAVE DAMPING IN INHOMOGENEOUS MAGNETIC FIELD. A. D. Piliya (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 93-8 (Jan. 1964). (In Russian)

Studies were made of cyclotron wave damping during reflection from magnetic surfaces in low-temperature plasma. Wave reflection coefficients were found. At low temperature the coefficient is neither a function of temperature nor plasma density and is equal to $\frac{1}{3}$. (tr-auth)

15401 ELECTRON DISTRIBUTION FUNCTION IN A POSITIVE MERCURY DISCHARGE COLUMN. [PART] II. N. A. Vorob'eva, Yu. M. Kogan, R. I. Lyagushchenko, and V. I. Milenin (Leningrad State Univ.). Zh. Tekhn. Fiz., 34: 146-8(Jan. 1964). (In Russian)

The electron energy distribution function was studied for a fixed energy range. At low pressures the distribution is Maxwellian, while at high pressures the distribution deviates from Maxwellian due to insufficient fast-electron concentration. (tr-auth)

15402 ON THE THEORY OF PLASMA COMPRESSION BY ELECTROMAGNETIC WAVES. I. V. Ioffe (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 189-90(Jan. 1964). (In Russian)

An analysis was made of plasma compression by electromagnetic waves, considering wave penetration. (R.V.J.)

15403 ON MEASURING PROMPT VELOCITY OF PLASMA BUNCH. R. Kh. Kurtmullaev, Yu. E. Nesterikhin, and A. G. Ponomarenko. Zh. Tekhn. Fiz., 34: 190-2(Jan. 1964). (In Russian)

Plasma bunch prompt velocity measured by Doppler broadening offers a magnitude pertaining only to a small section of the bunch. The method is not applicable for measuring the rate of bunch injection into a trap. Experiments were carried out using conical plasma sources that proved free of the above shortcomings. The scheme used Doppler broadening at oblique wave incidence, $\Delta f = 2f_0\, v/c \cos\alpha$, (where α is the angle of incidence and $v/c \ll 1$). A typical oscillogram (f_0 = 37000 Mc, $\alpha = 40°$ and source intensity U_c = 2 kw) is included. In addition to velocity, the time (t_i), space ($t_i v_i$), and separation of plasma layers were determined. (R.V.J.)

15404 THE ADIABATIC MOTION OF CHARGED PARTICLES. Theodore G. Northrop (California. Univ., Berkeley. Lawrence Radiation Lab.). Interscience Tracts on Physics and Astronomy Number 21. New York, Interscience Publishers, 1963. 109p.

The adiabatic theory of charged particle motion is developed. Several applications of the theory are illustrated, and nonadiabatic behavior is briefly considered. (D.C.W.)

15405 DIAGNOSTIKA PLAZMY. (Plasma Diagnostics). B. R. Konstantinov, ed. Moscow, Gosatomizdat, 1963. 303p.

Thirty-five articles are compiled on experimental methods in high-temperature plasma investigations. Articles are devoted to methods of plasma parameter determination; plasma emission determined by infrared, ultraviolet, and x-ray methods; devices for plasma studies (electron-optical, lasers, and filament optics); microwave methods; determining charged particle concentrations by reflected wave characteristics; microwave interferometers and other instrumentation; corpuscular methods for plasma measurements; neutral particle fluxes from plasma; mass spectrometric particle analysis; plasma probing; bolometric and probe methods; and multielectrode probes. (R.V.J.)

15406 KINETIC THEORY OF UNSTABLE PLASMAS. P. Rutherford (Princeton Univ., N. J.). p.22-44 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics." Notre Dame, Ind., University of Notre Dame, 1963.

The equations governing the classical fully ionized plasma of electrons and ions interacting only through their mutual Coulomb interactions are examined to investigate plasma stability. (C.E.S.)

15407 INTERACTION OF A SUPERSONIC PLASMA STREAM WITH A DIPOLE MAGNETIC FIELD. J. B. Cladis, T. D. Miller, and J. R. Baskett (Lockheed Missiles and Space Co., Palo Alto, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1963, Preprint 64-89, 10p, $1.00. (CONF-392-5)

From Aerospace Sciences Meeting, New York, Jan. 1964.

A laboratory experiment is described that simulates some aspects of the interaction of the solar wind and the geomagnetic field. A Mach-2 hydrogen plasma stream from a pulsed coaxial gun was directed against a dipole magnetic field. The shape of the windward side of the magnetic cavity and the circulation of the sheet currents in the boundary were found to be in general agreement with results based on the single-particle model. The supersonic-fluid model is appropriate for the interpretation of further results. A bow shock wave appeared upstream from the nose of the cavity, and the plasma was observed to flow irreversibly through the shock front and around the cavity. Time-resolved photographs depict the dynamics of the interaction, revealing drifts of the plasma near the interface layer and penetration of the plasma into the magnetic cavity. At times, following the impact of the plasma on the field, the field near the magnet was found to be asymmetric and generally lower than the normal dipole field. The recovery time of the field to the dipole value was long in comparison to the decay time of the plasma pulse from the gun. (auth)

15408 CURRENT DISTRIBUTIONS IN LARGE-RADIUS PINCH DISCHARGES. R. G. Jahn and W. von Jaskowsky (Princeton Univ., N. J.). New York, American Inst. of Aeronautics and Astronautics, 1964, Preprint 64-25, 8p, $1.00. (CONF-392-10)

From Aerospace Sciences Meeting, New York, Jan. 1964.

In an effort to understand more fully the basic mechanisms of gas acceleration in pulsed plasma devices, a series of detailed magnetic probe experiments was performed on a variety of large-radius linear pinch discharges. From the space and time variations of the interior magnetic fields thus determined, the concomitant distributions of current density within the discharges were evaluated. In argon at initial pressures between 20μ and 3 mm, a 10-kv, 230-kc pulse from a 15 μfd capacitor bank is found to generate well-defined cylindrical sheets of current that propagate radially inward from the periphery of the electrodes. The observed radius-time trajectories of these sheets, and those of the accompanying luminous fronts were compared with theoretical snow-plow calculations, and are found to be reconcilable if some fractional "sweeping efficiency" is assigned to each of the observed current sheets. The applicability of the scaling laws implicit in the snow-plow formulation was explored experimentally by changing the initial pressure, the type of gas, the radius of the discharge, the capacitance and voltage of the external bank, and the inductance of the external circuit. (auth)

15409 EXPERIMENTS ON NONEQUILIBRIUM IONIZATION DUE TO ELECTRON HEATING. J. L. Kerrebrock and M. A. Hoffman (Massachusetts Inst. of Tech., Cambridge). New York, American Inst. of Aeronautics and Astronautics, 1964, Preprint 64-27, 12p, $1.00. (CONF-392-12)

From Aerospace Sciences Meeting, New York, Jan. 1964.

An experimental study was conducted of the nonequilibrium conductivity of mixtures of argon and potassium. A pure plasma is produced in thermal equilibrium at temperatures up to 2500°K by means of a steady flow tantalum heat exchanger. Conductivity measurements made with probes between the electrodes indicate that the Two-Temperature Conduction Law proposed is valid for electron concentrations above about 10^{13} cm^{-3}. The effective energy loss factor depends on the size of the apparatus and was found to be 10 for the test sections used in these experiments. At lower electron concentrations the theory is in error, probably because the electron energy distribution is very non-Maxwellian. In this region the electric field goes through a maximum with increasing current density, suggesting that it may be difficult to make the transition to the higher electron density nonequilibrium state from the initial low electron density equilibrium state in an MHD generator. (auth)

15410 INELASTIC ATOMIC COLLISIONS IN PLASMAS. S. N. Milford (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). New York, American Inst. of Aeronautics and Astronautics, 1964, Preprint 64-54, 21p. $1.00. (CONF-392-14)

From Aerospace Sciences Meeting, New York, Jan. 1964.

The collision parameters for a thermal plasma and asymptotic cross sections for typical collision processes are discussed. Electron collisions with ground and excited states of hydrogen and with other atoms and ions are discussed. Heavy-particle collisions are also considered. 90 references. (R.E.U.)

15411 THERMONUCLEAR RESEARCH IN WESTERN EUROPE. D. W. Kerst (Univ. of Wisconsin, Madison). 6p. (CONF-414-5)

From Conference on Direct Energy Conversion, Argonne, Ill., Nov. 1963.

Research programs at several laboratories in Western Europe are discussed. Included are the Royal Institute of Technology, Stockholm; the University of Uppsala, Sweden; the Danish Atomic Energy Laboratory, Risø; Italian Laboratory at Frascati; Max-Planck Institute in Munich; Fontenay-Aux-Roses, France; and Culham-Harwell, England. (R.E.U.)

15412 THE MAGNETIC CONFINEMENT OF AN ELECTRIC ARC IN A TRANSVERSE SUPERSONIC FLOW. Charles E. Bond (Univ. of Michigan, Ann Arbor). New York, American Inst. of Aeronautics and Astronautics, 1964, Preprint 64-26, 12p, $1.00. (CONF-392-11)

From Aerospace Science Meeting, New York, Jan. 1964.

Results are presented of an experimental investigation of the effects of supersonic convection on the positive column of a direct-current electric arc. The experimental setup consists of two rail electrodes mounted in a supersonic wind tunnel and oriented parallel to the tunnel free stream. External coils provide a transverse magnetic field which is mutually perpendicular with the arc current and free stream. The coils are placed such that there is a monotonic increase in flux density from the upstream to the downstream ends of the rails. The arc is initiated by means of an exploding wire between the upstream ends of the rails. The plasma column generated is then convected downstream along the rails by the supersonic flow until a point is reached where aerodynamic and electromagnetic forces come into balance. The arc remains in the vicinity of this point until the current is shut off. (auth)

15413 MICROWAVE DIAGNOSTIC STUDIES IN ELECTRODELESS DISCHARGE PLASMAS. Peter P. Keenan and Frank L. Kelly (Lockheed-California Co., Burbank). 20p. (CONF-363-17)

From International Symposium on Plasma Phenomena, San Diego, Calif., Oct. 1963.

An experimental study of microwave diagnostic techniques as applied to electrodeless discharge plasmas is presented. Relatively dense plasmas ($\sim 10^{12}$ electrons/cm^3) are created by inductive coupling from a radio frequency (40 Mc) coil using a one kilowatt generator. A microwave diagnostic system was developed that permits X-band (8840 Mc) waveguide transmission in the TM_{01} mode through this plasma without appreciably loading the r-f excitation coil. Simple slotted line probing techniques were developed that are capable of measuring the point-by-point plasma densities with a high degree of accuracy in relatively dense plasmas using only a single microwave frequency. The techniques described here are to be applied to a large 100 kilowatt plasma generator now nearing completion. (auth)

15414 ELECTRONIC RATE PROCESSES IN NON-EQUILIBRIUM PLASMAS. Frank Robben (Univ. of California, Berkeley). New York, American Inst. of Aeronautics and Astronautics, 1964, Preprint 64-56, 8p, $1.00. (CONF-392-16)

From Aerospace Sciences Meeting, New York, Jan. 1964.

The effect of the inclusion of electron-excited atom collisions in a nonequilibrium atomic plasma is described, particularly with reference to a recombining plasma. It is shown that this results in a greatly increased rate of recombination for most laboratory atomic plasmas, compared to pure radiative recombination. Some experimental confirmation is discussed, and some comments are made on several plasma problems in which these effects are important. (auth)

15415 COLLISION INDUCED DISSOCIATION RATES IN THERMAL PLASMAS. C. Frederick Hansen (General Motors Defense Research Labs., Santa Barbara, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Preprint 64-55, 9p, $1.00. (CONF-392-15)

From Aerospace Sciences Meeting, New York, Jan. 1964.

Collision-induced dissociation rates for diatomic and triatomic molecules are estimated from a version of the available energy theory. The collision is assumed to excite one mode of internal momentum in an unbounded Boltzmann distribution, and the number of energy modes used in the dissociation process is taken to be the number of internal modes that disappear when the molecule breaks apart. This model is found to agree with available experimental data, generally within a factor of 10, over a wide range of temperature and for a wide variety of collision partners. 38 references. (auth)

15416 EXPERIMENTS CONCERNING NON-EQUILIBRIUM CONDUCTIVITY IN A SEEDED PLASMA. E. E. Zukoski, T. A. Cool, and E. G. Gibson (California Inst. of Tech., Pasadena). New York, American Inst. of Aeronautics and Astronautics, 1964, Preprint 64-28, 12p, $1.00. (CONF-392-13)

From Aerospace Sciences Meeting, New York, Jan. 1964.

Conductivity measurements were made in a plasma composed of argon seeded with potassium vapor. The gas temperature was 2000°K, the pressure was one atmosphere, the potassium concentration was between 0.22 and 0.80 mole per cent, and the current density was between 1 and 80 amp/cm^2. The conductivity values obtained experimentally agree qualitatively with theoretical values calculated by the two-temperature model for nonequilibrium conductivity, but the experimental values are about 50 per cent lower. Light intensity data were analyzed to obtain electron temperature estimates, and these estimates were in good agreement with electron temperatures calculated from the conductivity data. Relaxation times for the conductivity in response to a step function change in the electric field were found to be proportional to $(n_{eo}/\sigma_0 E^2)$ and were a few tens of microseconds for a field strength in the range 3 to 10 volts/cm. This dependence indicates that the ionization rate is limited primarily by the heating rate for the plasma. The short relaxation times suggest that the ionization occurs by a multi-step process. The analyses of conductivity and light intensity data obtained during the transient period indicate that the electron temperature reaches an appreciable fraction of its final value during the first few microseconds and changes much more slowly thereafter. (auth)

15417 ON THE NONADIABATIC MOTION OF A CHARGED PARTICLE IN AN AXISYMMETRIC MAGNETIC BARRIER. J. Reece Roth (Cornell Univ., Ithaca, N. Y.). 32p. (CONF-78-21)

From American Physical Society 1963 Summer Meeting, Buffalo, June 1963.

A study was made of the motion of a single charged particle in the magnetic induction generated by an axisymmetric current sheet, the current of which was sinusoidally modulated along the axis. Several adiabatically invariant quantities were investigated, and it was found that $M_4 = |\underline{v} \times \underline{B}|^2/|\underline{B}|^3$ varied least along a given trajectory. A particle was considered to be adiabatic if M_4 varied by less than 5% during a single interaction with the magnetic barrier. An averaging process was found which made it possible to predict the relations between particle mass and

energy, and the magnetic induction strength and geometry, which could cause M_4 to vary by more than 5% during a single interaction with the magnetic barrier. Experimental apparatus was constructed that made it possible to study a single interaction of a beam of charged particles with a magnetic barrier under steady-state conditions. An experimental procedure was developed that made it possible to detect the transition from adiabatic to nonadiabatic reflection of the ion beam, and the results were compared with the results of the numerical computation. (auth)

15418 DEVICE FOR MICROWAVE PROBING OF PLASMA. V. B. Brodskii, B. M. Belitskii, S. E. Zagik, V. A. Lyutomskii, and A. V. Spiridonov. Russian Patent 154,335.

A device for the microwave probing of a plasma by penetration or reflection is described. It consists of ellipsoidal mirrors, transmitting and receiving irradiators, an shf oscillator, a waveguide feed system, a receiver, and a multibeam oscilloscope. To obtain several focused beams for the simultaneous recording of the distribution of free electrons in a plasma, a number of exciters corresponding to the number of operating channels is installed near the focal points of the elliptical mirrors. The mirrors are connected through the waveguide feed systems to one shf oscillator when operating at one frequency or to several shf oscillators when operating at several frequencies. They are also connected through the receiver to the multibeam oscilloscope. In the process of probing, the region of plasma under investigation is placed at a point where the far focal points of the ellipsoidal mirrors coincide. (OTS)

15419 PLASMA CONFINEMENT TRAP. V. S. Dergalov. Russian Patent 155,571. Oct. 21, 1963. Filed Feb. 22, 1962.

A plasma-confinement trap is described. To eliminate drift instability and increase the confinement time of the plasma particles, it is designed in the form of a tube with funnels at both ends, which are covered by caps also in the shape of funnels. The current-carrying windings, which create oppositely directed magnetic fields inside the trap, are wound around both tube and caps. (OTS)

Shielding

15420 (N-63-19990) A NOTE ON THE INFLUENCE OF SHIELD GEOMETRY ON AIR DOSE AND TISSUE DOSE FROM PROTONS WITHIN A SPACE VEHICLE. Report No. 25. Hermann J. Schaefer (Naval School of Aviation Medicine, Pensacola, Fla.). Apr. 25, 1963. 18p.

For three typical space-radiation proton spectra assuming 4π incidence, the effect of shield geometry on the distribution of air dose within a spherical shell of uniform wall thickness and within a conical vehicle with a heavy heat shield at the base is analyzed theoretically. Highly structured dose patterns are obtained even for the completely symmetrical spherical vessel. Comparative analysis of the depth dose distribution in a tissue phantom of 30 cm diameter, at two different locations in the conical vehicle, shows that greatly different tissue doses can prevail at locations that show equal air doses. It is concluded that the tissue dose in the body of the astronaut cannot be accurately inferred from stationary radiation sensors, but requires instruments carried on the body. (auth)

15421 (NASA-TN-D-2122) A MONTE CARLO CALCULATION OF THE NUCLEAR COLLISION DENSITY OF PRIMARY GALACTIC PROTONS IN A SLAB OF ALUMINUM. Millard L. Wohl (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Mar. 1964. 16p.

A Monte Carlo program was written for the IBM 7090 computer. The code considers protons in the primary galactic energy range (0.1 to 10 Bev) impinging at angles of 0, 30, 45, and 60°, as well as isotropically, on an infinite slab of aluminum 55 cm thick. The average proton nuclear collision density in each of six laminar regions of the slab is computed. In addition, the energy distribution of evaporation neutrons from the resulting excited nuclei is computed, and the statistical model is assumed to be valid. The proton collision density may be used as the spatial source density distribution for calculations of the transport of the secondary neutrons. (auth)

15422 (NBS-MON-69) SHIELDING AGAINST GAMMA RAYS, NEUTRONS, AND ELECTRONS FROM NUCLEAR WEAPONS. A Review and Bibliography. J. H. Hubbell and L. V. Spencer (National Bureau of Standards, Washington, D. C.). Feb. 24, 1964. 38p.

The problem of predicting dose rates and of estimating the effectiveness of shielding from radiations resulting from nuclear explosions is discussed. A number of existing calculations and supporting experiments regarding the penetration and diffusion of gamma rays, neutrons, and electrons through air and bulk materials are summarized. Indications are given of gaps in such input information. A selection of 485 references from the unclassified literature is presented, of which 388 are cataloged as to source geometry and energy, absorber material and configuration, type of data presented, and method of calculation or experimental technique. These cataloged references include radiation field studies ranging from the point-source infinite-medium situation up through such complicated geometries as fox-holes, shelters, and conventional structures. The other references are of a general or review nature or contain input spectral data. (auth)

15423 (NP-13626) A MONTE CARLO METHOD FOR THE ANALYSIS OF GAMMA RADIATION TRANSPORT FROM DISTRIBUTED SOURCES IN LAMINATED SHIELDS. M. Leimdoerfer (Sweden. Försvarets Forskningsanstalt, Stockholm). Feb. 1964. 35p.

A method for calculating the penetration and energy deposition of gamma radiation, based on Monte Carlo techniques is described. The essential feature is the application of the exponential transformation to promote the transport of penetrating quanta and to balance the steep spatial variations of the source distributions that appear in secondary gamma emission problems. The estimated statistical errors in a number of sample problems, involving concrete shields with thicknesses up to 500 cm, are shown to be quite favorable, even at relatively short computing times. A practical reactor shielding problem is also shown, and the predictions are compared with measurements. (auth)

15424 (NP-13719) ON THE USE OF MONTE CARLO METHODS FOR CALCULATING THE DEEP PENETRATION OF NEUTRONS IN SHIELDS. M. Leimdoerfer (Sweden. Forsvarets Forskningsanstalt, Stockholm). Mar. 1964. 16p.

The exponential transformation, previously applied to problems concerning deep penetration of photons in plane geometry, is applied to problems of deep penetration of neutrons in spherical geometry. The representation of nuclear data is briefly described and the extension of the exponential transformation technique to spherical geometry is discussed on a quite general basis, to show the proper way of derivation in other systems of coordinates. In a sample problem, concerning the dose rate versus distance

(up to 210 cm) from a point fission source in concrete, the present method is compared with the Moments Method and excellent agreement is shown. (auth)

15425 (UNC-5072) SHIELD SMALL SOURCE EXPERIMENTS. Summary Report. R. Schamberger, J. Celnik, and R. Ross (United Nuclear Corp. Development Div., White Plains, N. Y.). Nov. 8, 1963. For General Motors Corp. Allison Div., Indianapolis. Contract AT(30-1)-3078, Subcontract No. 1. 69p.

A shielding experiment was performed that provided a proof test of the shield calculation methods used in the MCR shield desing and provides a partial confirmation of cross-section data. Measurements were made with a gamma spectrometer behind a configuration consisting of a layer of gamma shielding material followed by a neutron shield, with the configuration exposed to neutrons from a Po–Be source. The test configuration is illustrated. Secondary gamma rays produced in the assembly were measured with the spectrometer and compared directly with calculations. Calculations were performed with the ADONIS three-dimensional rectangular geometry Monte Carlo code, which is derived from the one-dimensional Monte Carlo codes used in the basic MCR shield analysis. Experiments were performed with samples of iron, lead, and stainless steel, and calculations were completed for the no-sample configuration and for an iron sample. Experimental and calculated detector response for these two cases are compared. Agreement is within a factor of two at all energies, and the calculated energy deposited in the crystal is within 25% of that observed for the no-sample case and within 15% for the iron case. This agreement demonstrates the validity of the experiment and of the basic calculation techniques used, and gives support to the secondary gamma production cross sections used for iron. (auth)

REACTOR TECHNOLOGY

General

15426 (ANL-6810) REACTOR DEVELOPMENT PROGRAM. Progress Report, December 1963. (Argonne National Lab., Ill.). Jan. 15, 1964. Contract W-31-109-eng-38. 66p.

Development progress is reported on fast reactors, liquid metal cooled reactors, ZPR-III No. 22 and 44, ZPR-VI No. 1, ZPR-IX, Borax-V, Faret, EBR-I, EBR-II, Treat, Fermi Fast Breeder Reactor, critical assemblies, Argonne Advanced Research Reactor, EBWR, magneto-hydrodynamic cells, thermionic cells, fuel cells, and boiling water reactors. Reactor technology is reported on fuel development, physics, heat and fluid engineering, materials development and properties, chemical separations, nuclear safety, and corrosion testing. (N.W.R.)

15427 (EUR-543.e) DIFFUSIONAL AND KINETIC PHENOMENA ASSOCIATED WITH FOULING. CONSIDERATIONS ON THE EFFECT OF HYDRODYNAMIC AND THERMAL CONDITIONS. R. Nijsing (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 74p.

This study deals with diffusional and kinetic pehnomena bound up with fouling in organic cooled fuel elements. Descriptions have been given of diffusion processes accompanied by chemical reactions close to the heating surface. Fouling rates have been calculated employing pessimistic assumptions for chemical reaction rates and particle adhesion rates. The theoretical results agree reasonably well with experimental data recently obtained by A.E.C.L. of Canada. It is shown that the physical form in which impurities are present in the coolant (impurities dissolved or dispersed as particles in the coolant, size of particles a.s.f.) rather than their concentration determines fouling rates. (auth)

15428 (EUR-549.f) QUELQUES CARACTERISTIQUES DE PILES A NEUTRONS RAPIDES ET PILES ASSIMILEES. (Some Features of Fast and Related Reactors). Marie-Thérèse Henry (European Atomic Energy Community). Feb. 1964. 45p.

This survey features the fast neutron reactors, the fast neutron critical assemblies, the coupled and intermediate reactors which already exist, which are under construction, the construction of which has been decided, or which are being planned. For each installation, it comprises a short description limited to its purpose and main characteristics and mentions the progress of work and the name of the main owner and operator. (auth)

15429 (GEAP-4482) PROGRAM FOR THE DEVELOPMENT OF PLUTONIUM RECYCLE FOR USE IN LIGHT-WATER-MODERATED REACTORS. Eleventh Quarterly Report, October 1–December 31, 1963. M. A. Robkin (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Jan. 15, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 13p. (EURAEC-942)

A research program is being conducted to obtain experimental data in the irradiation of plutonium-enriched fuel to confirm a theoretical model for predicting isotopic composition and reactivity changes in plutonium-enriched, light-water-moderated reactors. Autoradiographs of unirradiated fuel indicated ~10% microsegregation of the PuO_2. The irradiations of flux wires and the project fuel element in VBWR are described; the fuel element was removed after ~5000 Mwd/t burnup when VBWR operation was stopped in Dec. 1963. Progress on the EPITHERMOS code is described. (D.L.C.)

15430 (NAA-SR-8610) FLOW-STABILITY TEST LOOP. W. H. Wickes, E. E. Stoner, and F. J. Halfen—F. Bergonzoli, ed. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 1, 1964. Contract AT(11-1)-Gen-8. 39p.

In an effort to improve the hazards evaluation of a loss-of-pressure accident in organic-cooled reactors, an existing test loop was suitably modified. The investigation was primarily concerned with the steady-state and pressure-transient behavior of boiling organic coolants flowing in a heated channel. The experimental system built is described and results of preliminary checkout tests given. (auth)

15431 (NAA-SR-Memo-8801) COPRA—AN IBM 7094 CODE TO EVALUATE THE ACTIVITY OF REACTOR COOLANTS AND CORROSION PRODUCTS. R. E. Kaiser (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 24, 1963. Contract [AT(11-1)-Gen-8]. 57p.

Up to 30 elements with 50 decay reactions can be analyzed. Cyclic irradiation of material flowing around the coolant loop is calculated as well as irradiation of material subjected to a constant flux. Plated or accumulated activities can be studied for cases where the cumulative material deposit is a linear or parabolic function of time. The results of application of this method to COMPACT reactor conditions are reported elsewhere. (auth)

15432 (NAA-SR-Memo-9423) CAESAR—A MULTIGROUP, ONE-DIMENSIONAL DIFFUSION EQUATION CODE WITH CROSS SECTION AVERAGING USING ENERGY SPECTRUM WITH ARES FOR THE RESONANCE. Dorothy C. Baller (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 1964. Contract [AT(11-1)-Gen-8]. 179p.

The FORTRAN program CAESAR, designed for a computer with a 32-k memory, performs various reactor calculations. The program is basically designed for use with a microscopic cross section library, but it is possible to enter macroscopic cross sections in some or all groups and in some or all regions. The finite difference equations are derived; and program options, input, and use are discussed. Sample input and output are included, together with library listings. (D.C.W.)

15433 (ORNL-3542) EFFECTS OF TEMPERATURE ON FISSION-PRODUCT DEPOSITION. M. N. Ozisik (Oak Ridge National Lab., Tenn.). Mar. 1964. Contract W-7405-eng-26. 28p.

An analytical model developed for steady state deposition of fission products from gas streams onto conduit surfaces is extended to include the effects of axial and radial temperature variations. A computer code which evaluates the equations is described and sample results are presented that compare the calculated values with experimental data. (auth)

15434 (TID-7669) THERMAL OPERATING PERFORMANCE OF NUCLEAR REACTORS. A Panel Discussion Held at the Fifth National Heat Transfer Conference, Houston, Texas, August 8, 1962. David Miller, ed. (Ar-

gonne National Lab., Ill.). Contract W-31-109-eng-38. 101p.

A panel discussion with seven members was conducted which discusses the thermal performance and related aspects of Dresden, BORAX V, Shippingport PWR, VBWR, EBWR, N.S. Savannah, and Yankee. The transcript of a tape recording of the discussion is given. Panel and floor questions and answers are also given. (D.L.C.)

15435 COORDINATION IN THE AEC NUCLEAR SAFETY PROGRAM. Nucl. Safety, 5: No. 2, 200-3(Winter 1963-64).

In the AEC organization, an Assistant Director for Nuclear Safety was established in order to separate the promotional and regulatory functions of AEC. The information feedback in the program is described. The letters of the Advisory Committee on Reactor Safeguards regarding the reactor safety research program and the spent-fuel shipment cask program are given in full. The activities of Atomic Industrial Forum and the participation of industry in the program are described. The objectives of the program are discussed. (D.L.C.)

15436 EVALUATION OF TWO-REGION-REACTOR PARAMETERS BY RANDOM NOISE MEASUREMENTS. Allen R. Boynton and Robert E. Uhrig (Univ. of Florida, Gainesville). Nucl. Sci. Eng., 18: 220-9(Feb. 1964).

An experimental method of measuring parameters peculiar to a two-region reactor is developed requiring the measurement of the cross-power spectrum between the outputs of the two reactor regions when a random reactivity input is given to one of the regions. Using band-pass filters and an analog computer, the cross-power spectrum between the outputs of the two regions in the University of Florida Training Reactor was measured. These data indicate that the propagation of a disturbance from one region of the reactor to the other region may adequately be described in terms of neutron-wave phenomena and that the method may be used to determine the multiplication factor of each region. (auth)

15437 THEORY OF PULSING TECHNIQUES. Edward Garelis (General Electric Co., Pleasanton, Calif.). Nucl. Sci. Eng., 18: 242-5(Feb. 1964).

An improved pulsing technique is described that should simplify the experimental procedure in obtaining reliable pulsed data for both the α-measurement and the $(k\beta/l)$ technique for subcritical assemblies. It is shown that an equilibrium pulse shape can be obtained by continuing the time-channel analyzer after the last neutron burst to record all of the neutrons arising from the delayed precursors, providing the recording starts simultaneously with the initial burst. The source strength (neutrons per burst) need not be constant. (auth)

15438 A NONLINEAR ANALYSIS OF A REACTOR WITH TWO TEMPERATURE COEFFICIENTS. Louis M. Shotkin (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 18: 271-9(Feb. 1964). (BNL-7288)

A nonlinear analysis of parameter regions in the "two-temperature" reactor stability problem is accomplished using methods developed in the USSR for treating ordinary differential equations. It is shown that in a model where both temperature-dependent quantities obey Newton's law of cooling, stable limit cycles exist and centers do not exist. If one of the quantities obeys an adiabatic cooling law, centers exist and stable limit cycles do not exist. Solutions with finite escape time are found to exist for certain sets of parameters and initial conditions. When at least one linear characteristic root vanishes, it is shown that a first integral exists and that it is possible to discuss reactor behavior in terms of this integral. (auth)

15439 A DIGITAL COMPUTER SOLUTION FOR SPACE-DEPENDENT NEUTRON KINETICS EQUATIONS. Amir N. Nahavandi and Richard F. Von Hollen (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 18: 335-50(Mar. 1964).

A set of one-group space-dependent neutron kinetics equations for reactor cores with spatially variable moderator density is developed. The solution to this set of differential equations is obtained numerically using an IBM-7094 digital computer. Employing the variational technique of von Neumann, a numerical stability criterion for space-dependent neutron kinetics equations is established. The analysis is useful in the determination of the core open-loop response as well as the reactor system transient behavior. The open-loop response of a typical boiling-water reactor core for several values of step change in reactivity was determined using the analysis. These are shown to be in agreement with the results of the classical space-independent neutron kinetics equations. The open-loop characteristic of the reactor core due to a step change in density distribution is also presented. The main distinguishing feature of the present study is the ability to determine the open-loop response due to disturbances (such as a series of successive step changes in density distribution) for which the classical space-independent approach provides no solution. Characteristics of this type are necessary in the dynamic analysis of boiling-water reactors where the system density distribution varies in time and space. A simple approximate method for the solution of the space-dependent neutron kinetics equations is also presented. (auth)

15440 ON THE VALIDITY OF THE CONSTANT-SOURCE ASSUMPTION FOR THE CELL PROBLEM. G. C. Pomraning (General Electric Co., Pleasanton, Calif.). Nucl. Sci. Eng., 18: 400-3(Mar. 1964).

The solution of the cell problem, i.e., thermal flux distribution in a fuel element and its associated moderator, is discussed. The effect of depression of epithermal flux at the fuel-moderator interface for the monoenergetic problem of epithermal resonance absorption in the fuel is considered in the cell disadvantage factor. (R.E.U.)

15441 A NEW APPROACH TO THE PROBLEM OF NEUTRON DIFFUSION NEAR BOUNDARIES BY MEANS OF ELEMENTARY DIFFUSION THEORY. J. L. Alvarez Rivas and E. Rodriguez Mayquez (Junta de Energía Nuclear, Madrid). Nukleonik, 5: 342-4(Dec. 1963).

The experimental study of thermal neutron flux distributions inside and outside absorbing rods immersed in a moderator demonstrates that if $\lambda_a < d$ (d = rod diameter), the elementary diffusion theory gives correct predictions of the experimental measurements, provided an appropriate coefficient of diffusion is chosen for the rod. This coefficient is determined by the material and diameter of the rod. The value of this coefficient is obtained by means of a crude model which gives $D = 1/3\ [\lambda_{tr} - (d)/(e^{d/\lambda_{tr}} - 1)]$, λ_{tr} being the transport mean free path of the material and d the diameter of the rod. In the present paper many experimental results of several authors were used to check the validity of this expression. (auth)

15442 RESONANCE INTEGRALS IN TIGHT LATTICES. Jon O. Berg (Babcock and Wilcox Co., Lynchburg, Va.). Nukleonik, 5: 345-8(Dec. 1963).

An analysis of the error introduced in resonance integral

calculations through the usual assumption of a constant slowing down source in the moderator is described. The method does not account for the spatial flux variation in the moderator, thus being limited to tight lattices and giving a lower limit to the error. Through a numerical example, it is shown that the error may be significant for lattices of practical interest. (auth)

15443 THE FOKKER-PLANCK AND LANGEVIN EQUATIONS OF A NUCLEAR REACTOR. Abdi Dalfes (Technical Univ. of Istanbul). Nukleonik, 5: 348-52(Dec. 1963).

The space- and energy-independent Markovian random processes that occur in a nuclear reactor without feedback are treated as a birth, death, and immigration process, and the Fokker-Planck and Langevin equations are obtained. Ignoring delayed neutrons, the solutions to the Fokker-Planck equation are formulated for a reactor with or without an external neutron source. (auth)

15444 PARAMETER STUDIES ON GAS-COOLED FAST REACTORS. Dieter Smidt (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 5: 353-60(Dec. 1963). (In German)

The mutual dependence of a large number of parameters was quantitatively determined for helium-cooled fast reactors with cylindrical fuel rods and UO_2-PuO_2 mixtures. A system of four equations describes the cooling-technical and neutron-physical behavior of the core and the secondary circuit. The variables can be arranged in four groups: temperatures, form parameters, circuit parameters, and the effect of the material composition. The variations of the specific output, the critical mass, and the total efficiency were studied in dependence on the four groups of variables. Some guide lines were worked out which facilitate the establishment of the four parameters for practical representation of a plant. (tr-auth)

15445 A SIMPLIFIED FORMULATION OF SPACE-ENERGY CELL THEORY. K. B. Cady and C. R. MacVean (Cornell Univ., Ithaca, N. Y.). 25p. (CONF-187-82)

From American Nuclear Society Meeting, New York, Nov. 1963.

A simple formulation of polyenergetic thermal utilization theory for heterogeneous lattices is proposed. The main ideas are those of Leslie, who postulated an infinite moderator region with a fictitious, energy dependent absorption which includes all heterogeneous properties of the lattice, and those of Amouyal, Benoist, and Horowitz who postulated absorption rates in terms of fuel and moderator escape probabilities. Simple approximations to energy dependent escape probabilities are discussed and lattice spectra are calculated for several light water lattices. (auth)

Auxiliaries and Components

Refer also to abstracts 13619 and 15425.

15446 (CEA-2378) PUISSANCE THERMIQUE ET RAYONNEMENTS RESIDUELS APRES ARRET DANS LES REACTEURS NUCLEAIRES. CALCUL DES SOURCES, ÉTENDUE DE MESURES SOUHAITABLES ET ÉPAISSEUR DE PLOMB POUR LES DÉTECTEURS. (Thermal Power and Residual Radiation After Shutdown of Nuclear Reactors. Calculation of the Sources, Range of Measurements Required, and Thickness of the Lead for the Detectors). J. Weill (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 13p.

Curves and formulas are presented for determining residual powers, relative levels of spontaneous fission, and the lead shielding for ionization chambers used for power measurements. The importance of artificial neutron sources is indicated, and a method for calculating these sources is given. (D.C.W.)

15447 (GEMP-270C) HIGH-TEMPERATURE MATERIALS AND REACTOR COMPONENT DEVELOPMENT PROGRAMS. VOLUME III. INSTRUMENTATION AND CONTROLS. Third Annual Report. (General Electric Co. Advanced Technology Services, Cincinnati). Feb. 28, 1964. Contract AT(40-1)-2847. 43p.

The development of instruments for controlling reactor operation is reported. A shim-scram actuator was designed incorporating an electromagnetic drive for shim and scram, a shim speed limiting device, and a force feedback position indicator. A three-channel trip circuit and a two-out-of-three logic circuit using controlled switches in place of transistors was designed, built, and tested. A capacitance-type temperature sensor was operated in an inert atmosphere at temperatures up to 3782°F. Models of a gridded and a compensated a-c ionization chamber were tested in both thermal neutron and gamma environments. The compensated a-c ionization chamber demonstrated better than 98% gamma compensation at a thermal-neutron flux of 5×10^{-11} nv and 1 Mw reactor power. Unpowered charged-fragment neutron detectors using boron-10 or uranium-235 as the emitter coating were demonstrated to respond linearly to changes of thermal-neutron flux. Potentials, developed within the detecting circuit, possibly due to contact potentials, are suspected to be the cause of detector output-current instability as a function of time. Fission counter operation at 816°C was demonstrated to be feasible, but operation was not entirely satisfactory. Adequate reactor power range neutron sensing to 538°C is feasible using uncompensated d-c ionization chambers. (N.W.R.)

15448 (NAA-SR-Memo-9183) MODERATOR HEAT TRANSFER ANALYSIS FOR SRE-PEP THIRD CORE. C. G. Johnson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 1, 1963. Contract [AT(11-1)-Gen-8]. 79p.

Moderator coolant gap widths for SRE-PEP are based upon a two-region 33 fuel element core with 3 special test fuel elements and 30 standard fuel elements having radial power peaking factors of 1.707 and 1.160, respectively, and operating at a mixed-mean coolant outlet temperature of 1192°F. Operating moderator coolant gap widths of 0.210-inch and 0.165-inch for the seven central test fuel elements (3 special plus 4 standard) and twenty-six standard driver fuel elements, respectively, will allow adequate moderator element cooling for the SRE-PEP core operating at 30 Mw(t) power. Between the first and second row elements, the gap width will be 0.1875-inch. The core tank-reflector annulus exit temperature must be maintained at 1132°F for standard 30 Mw(t) reactor operation. For reactor power operation above 30 Mw(t), the required mixed-mean coolant outlet temperature and annulus exit temperature for adequate moderator cooling are shown. Analysis of the division of heat flow between the main sodium and moderator coolants indicates that on the average, 65.7% of the heat generated within the graphite moderator is transferred to the moderator coolant. Therefore, curves, tables and detailed calculations have been based on a $\frac{2}{3}$, $\frac{1}{3}$ power split between the moderator coolant and main coolant, respectively. This result is independent of uniform graphite thermal conductivity changes due to cumulative exposure to fast neutrons. The effect of uniform changes in thermal conductivity within the graphite is merely to alter the magnitude of the temperatures and not the distribution of tem-

perature. This is indicated by the isotherms given for graphite conductivities of 12 and 42 Btu/hr-ft-°F, respectively. Studies of the central moderator element indicate that maximum graphite temperatures will eventually reach about 1260°F near the top of the element as graphite thermal conductivity is reduced by fast neutron exposure. According to the isotherms, a maximum graphite temperature increase of 144°F above the datum of 925°F may be expected at the midpoint of the central moderator element. At the beginning of life when graphite moderator thermal conductivity is ~42 Btu/hr-ft-°F, the overall core average moderator temperature is 938°F. After five years of reactor irradiation, damage by fast neutrons reduces the conductivity to ~12 Btu/hr-ft-°F and average moderator temperature increases to 971°F. The maximum horizontal temperature variation across the flats of the outside Zircaloy-2 clad was estimated to be 23.8°F. This variation occurs at the outlet to the central moderator element. The moderator coolant temperature difference at this point is 26.2°F. The moderator volume fraction at various temperatures is given for the central element and maximum power standard moderator element, respectively. The moderator cooling analysis was based upon 5.85% of total fission power deposited as heat in the moderator. (auth)

15449 (NAA-SR-Memo-9281) CONTROL ELEMENT HEAT TRANSFER PARAMETER STUDY FOR SRE-PEP THIRD CORE. C. G. Johnson and S. I. Schreiner (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 6, 1963. Contract [AT(11-1)-Gen-8]. 43p.

Control rod allowable linear heat rates have been established at 14.4, 17.6, and 21.0 kw/ft for limiting pull tube inside surface temperatures of 1800, 1900, and 2000°F, respectively for an initial cold radial helium gap of 0.023-inch. The predicted maximum heat rates are 12.26 kw/ft for 30 Mw(t) reactor operation and 16.35 kw/ft for 40 Mw(t) operation. The corresponding pull tube temperatures are 1717 and 1861°F, which are within the range of allowable temperatures. An hydraulic analysis of the control rod channel indicates that an annulus thickness of 0.364-inch will provide adequate cooling of the proposed 4 shim control rods to 40 Mw(t) operation or higher. This reflects an increase of 0.114-inch over the thickness of 0.250-inch for the annulus used in previous designs. For operation above 30 Mw(t), both the mixed-mean reactor outlet and core tank-reflector annulus outlet sodium temperatures must be lowered by about 42°F. The control rod coolant outlet temperature is maintained at 1200°F or less under normal operation by controlling the core tank-reflector annulus outlet temperature which is required to be set at about 1132°F. The initial cold radial helium gap of 0.023-inch between the absorber and thimble decreases to about 0.021-inch for normal operation. Proper movement of the control rod is therefore assured. The inner helium gap between absorber and pull tube of 0.1125-inch reduces to 0.110-inch under thermally expanded conditions. Because the heat generation rate in the pull tube is only about 5% of the total, there is little incentive to change the inner helium gap size. (auth)

15450 (NAA-SR-Memo-9336) HEATING IN CONTROL RODS FOR USE IN THE 525-Mwe SGR. H. E. Jackel (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 18, 1963. Contract [AT(11-1)-Gen-8]. 26p.

The amounts of heat generated in a Dy_2O_3 poison rod and in two Haynes-25 poison rods were calculated at various positions along the rods and for several degrees of insertion of the rods into the core. The Dy_2O_3 rod consisted of a 0.19 in. annulus of Dy_2O_3 between a 2.12 in. diameter graphite rod, and a 2.500 in. I.D. by 0.18 in. wall Hastelloy-X tube. The Haynes rods were 2.84 in. OD tubes, one with a 1.00 in. wall and the other with a 0.375 in. wall, with work on the Haynes rods being concentrated upon the one with the thinner wall. Heat generation rates for gamma rays born within the poison were calculated using the GRACE-II code for various positions along rods which were ¼, ½, ¾, and fully inserted into the core. For both rods, the peak heat generation rate occurred near the tip of the ¾ inserted rod, and was, after the addition of decay heating, 19.6 kw/ft for the 0.375 Haynes rod and 20.9 kw/ft for the Dy_2O_3 rod. The corresponding average values were 6.9 kw/ft and 7.1 kw/ft respectively. To these values must be added the heat generated by the absorption of gamma rays born outside the rods. This was estimated to be up to 0.747 kw/ft average for the rods. These estimates were based on the heat generation in the graphite of the 525 Mw(e) ASCR. The accuracy of the Haynes calculations were estimated to be ±12%. Due to the adjustments to the results for the Dy_2O_3 rod which were necessary to obtain agreement with the calculations of leakage probabilities, the accuracy of the Dy_2O_3 results is +0% to −15%. The variation with time of the decay power for various situations was investigated and equations are given, along with some simplifications. Also investigated were the distribution of the energy originating in the rod between the rod and the moderator, and the effect of increasing the thickness of the Dy_2O_3 annulus, from 0.19 inch to 0.25 inch, on the heat generation. (auth)

15451 THEORY AND PRACTICE OF DETERMINING LEAK RATES OF REACTOR SAFETY CONTAINMENTS. H. M. Becker and H. J. Wagener (Technische Uberwachungs-Vereins Rheinland e. V., Aachen). Atomwirtschaft, 9: 24-8 (Jan. 1964). (In German)

The manufacturing costs of reactor vessels increase with the requirements on their leak tightness. These requirements should therefore not be made higher than is necessary for the relevant application. To determine the leak rate of a large container it is necessary to measure the total pressure in the container, the mean absolute air temperature, and the mean specific water vapor content. A measuring process was developed in which a metal wire is used as a resistance thermometer. Because of the difficulties accompanying the use of a free, stretched wire in a large container a hemp rope was used as a carrier for the wire which was laid between the strands. The theory and practice of this process are described in terms of the practical example provided by the tightness testing of the reactor chamber of the DIDO reactor (FRJ-2) in the Jülich Nuclear Research Center. The method had the expected advantages in addition to an improvement in the accuracy of measurement. It proved possible to construct the measuring arrangement and mount the cable in about three hours. The investigation described occupied only 2 to 3 workers for 24 hours and, compared with similar tightness tests on reactor chambers performed using other arrangements, led to a considerable lowering of costs. After the experiment the calibration of the cable was again checked without any change of resistance or of temperature coefficient being detected within the limits of measurement. (auth)

15452 NUCLEAR MATERIALS: WHAT'S OUR FUTURE? Can. Chem. Process., 47: 63; 65-6(Apr. 1963).

The potential of D_2O-cooled reactors as compared with organic cooled reactors is discussed. Properties of heavy water, OM, and OMP coolants are compared. The econom-

ics and production of heavy water and the organic coolants are also discussed. (P.C.H.)

15453 TEST LOOP FOR FUEL ELEMENTS. J. Maroto Muñoz, E. Artacho Savirón, and J. Montes Ponce de León. Energia Nucl. (Madrid), 7: 17-24(Oct.-Dec. 1963). (In Spanish)

The design and properties of the test loop constructed to irradiate JEN-1 fuel plates in a receptacle that occupies exactly the space of one fuel element are described. The primary circuit, the water purification circuit, and the instrumentation of this test loop are discussed. (J.S.R.)

15454 A SAMPLE CHANGER FOR A HORIZONTAL IRRADIATION CHANNEL. D. Hofmann and A. Wensel (Universität, Frankfurt am Main). Kerntechnik, 6: 20-1 (Jan. 1964). (In German)

An apparatus for manipulation of radioactive samples in a horizontal irradiation channel of the Frankfurt Research Reactor is described. The samples are used for studies of neutron capture γ rays. The apparatus has functioned successfully during a large number of manipulations. (auth)

15455 FAILURE OF ALIZE I REACTOR SAFETY SYSTEM. E. P. Epler. Nucl. Safety, 5: No. 2, 172-3 (Winter 1963-64).

While the failure of a reactor safety system coincident with a reactor excursion is frequently considered to be incredible, such incidents do occur. The causes of such incidents are outlined with examples of each. The March 15, 1960, incident at the French critical experiment facility Alize I is reviewed, and the steps taken to prevent similar incidents in the future are criticized. (D.L.C.)

15456 STRUCTURAL INTEGRITY OF CONTAINMENT SYSTEMS. L. R. Shobe. Nucl. Safety, 5: No. 2, 175-82 (Winter 1963-64).

A review is presented of recent results in studies of the adequacy of containment shells. Reactor breakup during runaway, scaling procedures, and lining materials are considered. (D.L.C.)

15457 DESIGN OF A PRESSURE BALANCED CONTROL ROD. F. K. Clements, A. D. Kartchner, R. S. Kern, and W. B. Lewis (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Sci. Eng., 18: 200-6(Feb. 1964).

A control rod is described whose drop performance is essentially independent of the flow of reactor coolant. Theoretical studies covering wide ranges of parameter variations give a broad picture of the rod's potentialities. (auth)

15458 DETERMINATION OF CADMIUM BURNUP IN REACTOR CONTROL RODS BY NEUTRON RADIOGRAPHY. Harold Berger, James H. Talboy, and Joseph P. Tylka (Argonne National Lab., Ill.). Nucl. Sci. Eng., 18: 236-41 (Feb. 1964).

A method of studying the burnup of high-cross section materials in nuclear reactor control rods by neutron radiography is described. The technique was applied to the examination of the burnup pattern of a CP-5 reactor control rod and was found to provide a detailed picture of the burnup pattern showing a very sharp transition region. The radiographic study was made by a comparison method in which the neutron transmission of the irradiated cadmium control material was compared to that of normal cadmium. In the regions in which the cadmium control material was highly depleted in Cd^{113}, the equivalent normal cadmium thickness comparison can be made to an estimated accuracy of 0.0006 inch. (auth)

15459 RADIATION AND CREEP ANALYSIS FOR STRAIN AND STRESS DISTRIBUTION IN TUBULAR FUEL ELEMENTS. Benjamin M. Ma and Glenn Murphy (Iowa State Univ., Ames). 48p. (CONF-187-104).

From American Nuclear Society Meeting, New York, Nov. 1963.

Strain and stress distributions resulting from radiation and creep effects in long externally and internally cooled tubular reactor fuel elements were determined analytically. The primary effects of thermal-cycling growth, irradiation growth, and swelling of uranium alloy or ceramic-uranium fuel materials under operating conditions of power reactors were taken into consideration. Based on simple diffusion equations, an exact solution of the modified Bessel functions and an approximate solution (using a parabolic function) for neutron flux distribution were obtained. From the relation that rate of heat generation is proportional to neutron flux the rate of volumetric heat generation in the fuel was found. By using Poisson's equation for heat conduction the excess temperature developed in the fuel zone was determined. It was concluded that the order of magnitude of the neutron flux, thermal and radiation dilatation, and thickness of cladding material highly influence the strain and stress distributions in fuel elements. (P.C.H.)

15460 THERMAL NEUTRON SPECTRA NEAR ABSORBERS. C. B. Bigham. 15p. (CONF-187-89)

From American Nuclear Society Meeting, New York, Nov. 1963.

Perturbations in a nearly perfectly thermal neutron flux distribution, caused by the introduction of an absorber into the moderating medium in which the neutrons are moving, are measured. Experimental results are shown for B and Cd absorbers in both Lucite and graphite moderators. Both the variations in the neutron density and the perturbation in neutron temperature are measured. It is concluded that the temperature perturbation consists of two more or less separable components, viz., "transmission hardening" and "boundary hardening," which depend on the cross sections of the absorber and moderator, respectively. (T.F.H.)

15461 IMPROVEMENTS IN OR RELATING TO PERIOD METERS FOR NUCLEAR REACTORS. Donald Harrison (to United Kingdom Atomic Energy Authority). British Patent 950,946. Mar. 4, 1964. Filed Oct. 19, 1960.

A logarithmic reactor period meter is described that contains a resistive potential divider with two oppositely poled semiconductor diodes. The input time-constant of the logarithmic amplifier is made small and the maximum smoothing time-constant of the differentiating amplifier is made large enough to give an acceptable noise level at low input currents. (R.E.U.)

15462 IMPROVEMENTS IN OR RELATING TO PERIOD METERS FOR NUCLEAR REACTORS. Donald Harrison, Eliot Patrick Fowler, and Gerald Keith Lunn (to United Kingdom Atomic Energy Authority). British Patent 950,947. Mar. 4, 1964. Filed May 12, 1961.

A reactor period meter is described having a logarithmic amplifier and a differentiating amplifier containing a smoothing circuit with a time-constant controller. The logarithmic element in the amplifier is a thermistor. (R.E.U.)

15463 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Michel Chauvin (to Commissariat a l'Energie Atomique). British Patent 951,165. Mar. 4, 1964. Priority date Apr. 10, 1961, France.

A supporting device for the core bed of a fast neutron

liquid metal-cooled reactor is described that permits radial expansion of the bed and offers a leakage path of predetermined cross section. (R.E.U.)

15464 A NUCLEAR REACTOR AND METHOD OF VARYING ITS REACTIVITY. (to General Nuclear Engineering Corp.). British Patent 951,276. Mar. 4, 1964. Priority date Dec. 15, 1960, United States.

A method is described for controlling reactivity in a reactor using poisons that are movable in selected zones of the core. In the vertical channels in the core, the poison elements are located at rest in the lower portions and may be selectively moved into the central core region by fluid flow from the bottom. Gravity is used to lower the poisons from upper regions of the core. (R.E.U.)

15465 IMPROVEMENTS RELATING TO CONTROL DEVICES FOR NUCLEAR REACTORS. John Anthony Wynne Huggill (to A.E.I.-John Thompson Nuclear Energy Co., Ltd.). British Patent 951,608. Mar. 4, 1964. Filed Sept. 1, 1959.

A type of control rod for a vertical fuel-channel reactor is described that is mounted on the ends of the fuel elements. The device is made of concentric annular carriers with either boron material or cadmium–silver alloy as the neutron absorber so that by relative motion of the carriers the amount of overlap of effective neutron absorbent area can be varied in relation to the temperature in a reactor zone to affect control. Application is made to plutonium production reactors that exhibit positive moderator temperature coefficient of reactivity. (R.E.U.)

15466 NUCLEAR REACTOR DUCT CLOSURE DEVICE. Leon Le Flem, Daniel Voeltzel, and Jacques Jouin (to Commissariat à l'Energie Atomique). U. S. Patent 3,124,516. Mar. 10, 1964. Priority date May 5, 1959, France.

A device for closing ducts in a reactor is described with improved radiological shielding. The device comprises two axially aligned drums mounted for staggered rotation, thus providing adequate shielding. (R.E.U.)

Crititicality Studies

15467 (CONF-187-108) THE DETERMINATION OF k_∞ FROM MEASUREMENTS ON A SMALL TEST SAMPLE IN A CRITICAL ASSEMBLY (thesis). David Dayton Lanning (Massachusetts Inst. of Tech., Cambridge). May 1963. Contract AT(30-1)-906. 199p.

From American Nuclear Society Meeting, New York, Nov. 1963.

The determination of the infinite multiplication factor, k_∞, from measurements on a small test sample was investigated by both theoretical and experimental techniques. Theoretical relations were developed to calculate the error in the measurement due to a mismatch between the flux ratios in the critical assembly and those of the test sample. Experiments were carried out with the Physical Constants Testing Reactor (PCTR) to obtain values of the multiplication factor for comparison with the theoretical results. Calculations with two-group theory gave results that agreed with the experimental results when the test sample, with natural uranium fuel, was surrounded by a buffer region of the same material. When this buffer region was loaded with highly enriched fuel, the errors in the measured values were not predicted by the two-group theory. Three-group theory relations were derived which gave calculated values in agreement with the experimental values and indicated that a mismatch of the epithermal neutron group leads to the measured differences in the value of k_∞ for the two buffer types. A new technique was developed for the measurement of a multiplication factor, k_{∞_T}, which is the sum of an epithermal multiplication factor, k_{∞_e}, and a thermal multiplication factor, k_{∞_t}. k_{∞_t}, k_{∞_e}, and k_{∞_T} were measured for the test sample; and the value of k_{∞_T} was found to agree with the value of $k_{\infty_{1/v}}$, as measured by the PCTR technique. The derivation of the values of k_{∞_T} from the experimental measurements led to the development of a method for evaluating the effective neutron temperature in the graphite moderator. Methods were also developed to derive epithermal group constants from the measured values of k_{∞_e} and k_{∞_t}. (auth)

15468 (EUR-217.d(Pt. I and II)) UBER LOSUNGSVERFAHREN FUR DIE BOLTZMANN-GLEICHUNG. TEIL I AND II. (The Application of the Direct Method of the Variational-Calculus. Part I and II). K.-H. Mueller (Eurpoean Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 30p.

A functional is given in which the P_1 approximation to the Boltzmann equation of neutron dynamics is in the form of Euler equations. The requirement for the related extreme values is thus equivalent to the differential equation system of the P_1 approximation. The direct method of calculating variations can be used to solve the variation problem. An exclusive system of selection functions, suitable for concrete reactor problems, provides a clear and simple method for calculating criticality and neutron flux. The result of each of these three procedures is called reduced Boltzmann-eq. This matrix is an integro-diff.eq. in (1) velocity and time, (2) space and time, and (3) time. A successive application of transformation (2) after (1) or (1) after (2) is possible. Examples illustrate the essential steps of the consideration. (auth)

15469 (EUR-493.e) THE KINETIC THEORY OF A FAST REACTOR PERIODICALLY PULSED BY REACTIVITY VARIATIONS. G. Blaesser, R. Misenta, and V. Raievski (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 20p.

The inhour equation of a fast reactor pulsed by periodical reactivity variations is derived by two techniques. The first method defines a mean multiplication factor which is the ratio number of neutrons produced during one period to number of neutrons absorbed during one period. The second method uses a multiplication factor for the mean power which is defined by the ratio number of delayed neutron emitters formed during one power pulse to the number of delayed emitters decaying during one power pulse. The inhour equation obtained by the second method shows the influence on the inhour equation of the time intervals during which the reactor is subcritical. For cases in which the influence of these time intervals is negligible, the equivalence of the two derivations is shown. (auth)

15470 (EUR-530.f) DETERMINATION DE L'EFFET DOPPLER DES ELEMENTS FISSILES DANS LES REACTEURS RAPIDES. (Determination of the Doppler Effect of Fissile Elements in Fast Reactors). A. Ancarani and E. A. Fossoul (Société Belge pour l'Industrie Nucléaire, Brussels). 1964. 84p. (CONF-193-8)

From 8th Nuclear Congress, Rome, June 1963.

The Doppler effect due to U^{235}, Pu^{239}, U^{233}, and Pu^{241} for energies at which the resonances overlap strongly was investigated and evaluated using a statistical method, together with the multigroup breakdown method and effective cross sections proposed by Yiftah. The effect of the selection of

basic resonance parameters, such as the alpha capture/fission ratio and the degree of freedom of statistical distributions, was also determined. (D.C.W.)

15471 (GA-4838) MEASUREMENTS OF SUBCRITICAL REACTIVITY USING A PULSED-NEUTRON SOURCE. J. R. Brown (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Jan. 15, 1964. Contract AT(04-3)-167. 24p. (CONF-187-68)

From American Nuclear Society Meeting, New York, Nov. 1963.

Pulsed neutron source measurements were made for a series of subcritical to critical loadings on a bare U^{235} water assembly in slab geometry. For each loading, the assembly was repetitively pulsed, and the time distribution of thermal neutrons in the core was recorded on time analyzers. From these data, the reciprocal die-away time (α), the delayed neutron background, and the reactivity of the system were determined. Measurements at various positions in the assembly verified that spatial modes do not affect the reactivity determination. (auth)

15472 (GNE/Phys/63-15) A TWO-DIMENSIONAL ANALYSIS OF A SUBCRITICAL EXTERNALLY MODERATED CYLINDRICAL CAVITY REACTOR (thesis). Edmund A. Nawrocki (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Aug. 1963. 104p. (AD-418557)

Age-diffusion theory is used to perform a two-dimensional analysis of a subcritical, externally moderated, cylindrical cavity reactor. The external moderator is limited to the sides only; no end moderation is considered. The Fermi-age equation is solved for the moderator. Thermal diffusion equations for the core and moderator are also formulated and solved. An extraneous, line neutron source of strength $S_x \cos \pi z/h$ is assumed on the axis of the cylindrical cavity. Application of the diffusion theory boundary conditions gives an expression relating the core flux power constant with the fuel loading, reactor size, and the maximum source strength, S_x. Sample calculations are made for an assumed reactor size, and source strength, graphite moderator, and varying pressures and enrichments of UF_6 fuel. (auth)

15473 (ORNL-TM-781) HIGHER ORDER FISSION-PRODUCT POISONING OF U^{233} AND U^{235} FROM SELECTED ISOTOPES OF NEODYMIUM, PROMETHIUM, SAMARIUM, AND EUROPIUM. W. E. Thomas (Oak Ridge National Lab., Tenn.). Mar. 1964. Contract W-7405-eng-26. 62p.

Calculations of primary and secondary capture in sixteen nuclides from Nd^{145} through Eu^{155} were made for the following operating conditions: specific power, 0.5, 1.0, and 2.0 Mw/kg of fuel; fuel lifetimes of 0.5, 1.0, and 1.5 fissions per initial fissionable atom; with 30% of the fissions occurring in the epithermal range, in both U^{235} and U^{233} fuel. For comparison, a calculation was completed for U^{235} operating at a specific power of 1.0 Mw/kg, assuming 10% epithermal content. Two fuel concentrations were considered: constant throughout the fuel lifetime, and variable according to the initial condition that 0.4 atom of fuel material is produced per atom fissioned. The data are presented as poison fractions averaged over the fuel life. They are not terminal values but are more representative of the average performance at any time in a reactor fueled by continuous charge and discharge, e.g., uniform graded-exposure fuel distribution. The data indicate that a large percentage of the captures are secondary and that the percent of secondary captures increases with specific power, fuel lifetime, and epithermal content. The percentage of secondary captures decreases as the number of atoms of fuel produced per atom of fuel fissioned (initially) increases. Four source nuclides are jointly responsible for more than 90% of the secondary captures. In order of importance they are: Nd^{147}, Sm^{149}, Sm^{151}, and Sm^{152}. More than 90% of the primary captures occur in Pm^{147}, Sm^{149}, Nd^{145}, and Sm^{151}. It was found that the total captures in this fission-product chain were reduced ~50% when the fuel material was changed from U^{235} to U^{233}, all other parameters being fixed. (auth)

15474 (TID-20302) MEASUREMENT OF ASYMPTOTIC NEUTRON SPECTRA IN MULTIPLYING ASSEMBLIES CONTAINING U^{235}. R. E. Slovacek, E. R. Gaerttner, R. R. Fullwood (Rensselaer Polytechnic Inst., Troy, N. Y.); and D. R. Bach (Knolls Atomic Power Lab., Schenectady, N. Y.). [1964]. Contract AT(30-3)-328. 54p.

Asymptotic neutron spectra were measured in the center and from the surface of three U^{235} hydrogen-moderated multiplying assemblies using the pulsed neutron technique. Two of the assemblies were heterogeneous water-moderated and one was homogeneous paraffin-moderated. They were of different size and hydrogen to U^{235} ratios, so that absorption, leakage, and scattering varied. The measured spectra are compared with calculations based on Nelkin's scattering kernel for water and Goldman's scattering kernel for polyethylene (for the paraffin moderated assembly). Corngold's formulation is used in the epithermal energy range. The agreement with theoretical predictions is satisfactory when measured values of the asymptotic time-decay constant are used to calculate the spectrum. (auth)

15475 THE PHYSICAL CALCULATION OF REACTORS IN THE MULTIGROUP DIFFUSION APPROXIMATION. V. B. Troyanskii and S. B. Shikhov. Nekotorye Vopr. Inzh. Fiz., No. 4, 3-13(1963). (In Russian)

Multigroup diffusion equations were derived from the neutron transport equation using the P_1 approximation. After presenting the development of both the one-velocity diffusion equation and the age-diffusion equation, the lethargy intervals are introduced and the multigroup slowing-down-diffusion equations are presented for multiregion reactors, including the inelastic scattering. The results include the form of the group constants in terms of the basic neutron cross sections. The conditions, $A \gg 1$, under which this approximation is expected to be valid, are discussed. The matrix formalism for presenting the multigroup equations is extended to include the adjoint equation, leading to the discussion of the importance function, presenting appropriate boundary conditions at the material interfaces for both sets of equations. The method of expanding the flux in each group, insofar as its spatial dependence is concerned, in the terms of the wave functions appropriate to each region, is reviewed. Sources for all the cases are taken to be of the form of the fission spectrum in lethargy dependence. (TTT)

15476 SOME PROBLEMS IN THE CALCULATION OF HYDROGENOUS SYSTEMS. L. K. Shishkov and A. F. Piskunkov. Nekotorye Vopr. Inzh. Fiz., No. 4, 14-33(1963). (In Russian)

Starting with the Boltzmann equation in the diffusion approximation, the scattering by hydrogen was treated separately from the scattering by all other nuclei, which were considered as "heavy" for this purpose. The resulting equations were then put into the multigroup (in lethargy) form including inelastic scattering and using the fission spectrum as the source. The final results treated hydrogenous media in either the P_1 approximation or in a

"transport" approximation. The connection with the "moment method" was developed. The criticality problem is discussed formally using the matrix method. A discussion of the extrapolation length as a lethargy group quantity is presented. Results of fifteen-group calculations are presented in both approximations for the critical radius of an assembly based on a core consisting of a UO_2F_2–water solution with enriched uranium and compared with the experimentally determined dependence of the radius on hydrogen concentration. Similarly in a nine-group calculation the results from the two approximations for the age to 1.4 ev from fission in water–iron mixtures of various compositions are compared with experimental results. Twelve tables giving the group cross sections for several elements, especially hydrogen, are included in the appendix. (TTT)

15477 EFFECTIVE BOUNDARY CONDITION AT THE PLANE SURFACE OF A PERIODIC LATTICE. V. V. Khromov. Nekotorye Vopr. Inzh. Fiz., No. 4, 34-42(1963). (In Russian)

The effectiveness of a planar lattice of neutron-absorbing rods in cutting off the active core was considered. It was essential to be able to calculate the "greyness" of such an array. As a model for study an infinite medium was chosen, which supports a flux of monoenergetic neutrons. The absorbing material was disposed on the plane x = 0 in the form of long, thin strips, infinite in the z-direction. Each strip was of width "a" and separated in the y-direction from its neighbors on either side by a length "b", thus giving a period "T" to the absorber lattice, where T = a + b. Each strip was considered to be "black" to incident neutrons. The general solutions of the diffusion equation were used in each half-space in combination with "shadowing" conditions for the transport of neutrons across the absorbing plane to obtain the effective transparency, C_o, of the absorber lattice. The diffusing medium itself was allowed to be either absorbing or non-absorbing for neutrons. Limiting cases are discussed and compared with results from the Vinera-Khopfa method. A table of numerical results for the effective extrapolation length into one half-space from the other is given as a function of the period "T" and the transparency "C_o" (which depends on the ratio b/T). (TTT)

15478 RATIONAL MEASUREMENTS IN EXPONENTIAL EXPERIMENTS WITH A PROPORTIONAL COUNTER OR IONIZATION CHAMBER. A. N. Klimov. Nekotorye Vopr. Inzh. Fiz., No. 4, 47-58(1963). (In Russian)

A statistical analysis was made of the type of experiment wherein a relaxation length is measured with proportional counters or ionization chambers. The application of this analysis was restricted to cases where a simple exponential fall-off of radiation intensity exists. An expression for the standard deviation was developed. A least squares analysis was made in fitting the measured values to a best-fit relaxation length. The case of the optimum experiment was studied, and the expressions for optimum counting time at each point in relation to the optimum number of measuring points was obtained. (TTT)

15479 REACTOR KINETICS. M. L. Tobias. Nucl. Safety, 5: No. 2, 155-7(Winter 1963-64).

Recent work on a number of kinetic problems is discussed. Some of the subjects treated in the Sun Valley Conference on reactor kinetics (Oct. 1960) are discussed. Low-source startup kinetics and extrapolation of reactor transient data to potentially dangerous situations are considered. Examples are given of the applications of techniques for theoretical kinetic studies. (D.L.C.)

15480 MEASUREMENT OF DOPPLER COEFFICIENT BY HEATING A SMALL REGION OF A FAST REACTOR CRITICAL ASSEMBLY. P. Greebler. Nucl. Sci. Eng., 18: 287-9(Feb. 1964).

An expression is derived for the total change in neutron resonance absorption when only one region of the reactor is heated. The departure from the normal Doppler effect for U^{238} is calculated for a fast oxide-fueled reactor. (R.E.U.)

15481 TIME ANALYSIS WITH THE HELP OF THE ROSSI α METHOD. Eiichi Arai (Tokyo Univ.). Nukleonik, 5: 338-42(Dec. 1963). (In German)

For the determination of the neutron lifetime of a highly subcritical reactor, the Rossi α method is used. The distribution of the intervals of the pulses that were produced by a neutron counter installed in the reactor was measured with a time analyzer. The neutron lifetime of a reactor (the subcritical reactor of the Technical School, Tokyo), which consists of water and natural uranium in aluminum cladding, is about 55 μsec. (tr-auth)

15482 REACTOR PHYSICS STUDIES WITH PULSED NEUTRON SOURCES. R. Ramanna (Atomic Energy Establishment, Trombay, India). p.239-49 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Pulsed neutron sources were successfully used for studies of the kinetic behavior of neutrons in matter. Three studies are described: measurements of neutron lifetime in moderators to get the thermal neutron diffusion parameters, measurement of the decay constant of prompt neutrons in reactor assemblies, and neutron spectra measurements by time-of-flight techniques. (M.C.G.)

Design and Feasibility

15483 (EUR-592.e) REACTOR PHYSICS PROGRAM AT EURATOM CCR-ISPRA. V. Raievski (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 31p. (CONF-426-1)

From IAEA Study Group Meeting on Research Reactor Utilization, Athens, Sept. 1963.

General reactor physics work involving shielding, burnup, fast reactor physics and Monte Carlo programs is summarized, together with work directly associated with ORGEL development. The latter involved a program for ORGEL calculations, thermal neutron spectra, resonance escape probability, and fast neutron multiplication factors. (D.C.W.)

15484 (LAMS-3012) EXPERIMENTAL STUDIES RELATING TO ROTATING FLUIDIZED-BED REACTORS. H. P. Deinken, A. C. Juveland, and J. E. Dougherty (Los Alamos Scientific Lab., N. Mex.). Sept. 1963. Contract W-7405-eng-36. 38p.

A summary is presented of the work done on the mechanical properties of fluid beds at W-3. This information, in addition to that previously reported on heat transfer and material losses from fluid beds, is used to discuss a rotating fluidized bed reactor. No new difficulties with the rotating fluidized bed reactor concept have been found in these investigations which cannot be overcome. (auth)

15485 THE REACTOR DEVELOPMENT STUDIES OF THE NATIONALEN GESELLSCHAFT ZUR FORDERUNG DER INDUSTRIELLEN ATOMTECHNIK (NGA). A. F. Fritzsche. Schweiz. Ver. Atomenergie, Bull., No. 15, 6p. (Sept. 1963). (In German)

General illustrations of the accomplishment of reactor development are presented. The choosing of a reactor concept, the work in progress on heavy-water reactors, and studies of other reactor types are discussed. The chief part of the NGA program is development work on the heavy-water reactor. (M.C.G.)

15486 THE PROGRAM SCOPE FOR THE DEVELOPMENT STUDIES OF NGA. A. F. Fritzsche. Schweiz. Ver. Atomenergie, Bull., No. 20, 6p.(Nov. 1963). (In German)

The program scope for further reactor development and comparison studies of the Nationalen Gesellschaft zur Förderung der industriellen Atomtechnik is discussed. This program is directed toward further development of the heavy-water-moderated reactor at Lucens and to studies of other reactor types. Topics covered include: heavy-water reactor development, comparative studies and general investigations, studies on advanced reactor concepts, and expenditures on the program. (M.C.G.)

Fuels

15487 (GEAP-4361) ACCURATE NUCLEAR FUEL BURNUP ANALYSES. Seventh Quarterly Progress Report, June 1963–August 1963. B. F. Rider, C. P. Ruiz, J. P. Peterson, Jr., P. S. Luke, Jr., and F. R. Smith (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Sept. 1, 1963. Contract AT(04-3)-189. 27p.

Progress is reported on the development of accurate methods for determination of nuclear fuel burnup. A plot of the estimated plutonium-239 and uranium-235 fast and thermal chain yields relative to the uranium-235 thermal chain yields indicates that such nuclides are found to have constant yields at mass regions near 99, 138, and 148. Fission product neodymium is separated on a di(2-ethylhexyl) phosphoric acid (D2EHP) column for mass spectrometry. The behavior on the column of several other elements present in irradiated nuclear fuel and their possible influence on the separation of neodymium from irradiated fuel is reported. Fission product neodymium did not migrate in unmelted fuel; however, in molten fuel the refractory fission products were observed to be concentrated among the last materials to solidify. When neodymium-150 is used as an isotopic diluent for measurement of neodymium-148 from fission, the 142 mass position is also scanned to check for natural neodymium contamination. Equations for calculation of neodymium-148 and -142 by use of 142/150 and 148/150 ratios are derived. The ratio of mass 142/143 is more easily and accurately measured than the 142/150 ratio. The equations for calculation of neodymium-148 and -142 from measured 142/143 and 148/150 ratios are presented. (N.W.R.)

15488 (GESR-2006) DEVELOPMENT OF A NUCLEAR THERMIONIC FUEL ELEMENT. Quarterly Progress Report, Second Quarter, September 1, 1962–November 30, 1962. (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Contract AT(04-3)-189. 39p.

Materials Development. Vacuum furnace tests of UO_2–Mo and UO_2–W fuel-clad specimens at 1800 and 2000°C, respectively, showed no evidence of interaction. W-clad UO_2 test assemblies were fabricated for the pilot irradiation capsule. Converter Development. The fabrication of two in-pile/out-of-pile converters was completed, and the characteristics of one were determined. Reactor Design and Analysis. Preliminary thermal and stress analyses of the cells were made, and electrical resistance considerations in emitter-fuel clad thickness were examined. Critical mass calculations were made for thermionic reactor cores of varying sizes. (D.L.C.)

15489 (GESR-2007) DEVELOPMENT OF A NUCLEAR THERMIONIC FUEL ELEMENT. Quarterly Progress Report, Third Quarter, December 1, 1962–February 28, 1963. (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Mar. 15, 1963. Contract AT(04-3)-189. 45p.

Materials Development. Long-term vacuum and cesium furnace tests were carried out on UO_2–Mo and UO_2–W fuel-clad specimens at 1800 and 2000°C respectively; metallographic examinations of the vacuum-exposed specimens show no evidence of interaction or interdiffusion. A pilot irradiation was made on UO_2–W. Fabrication of Mo- and W-clad enriched UO_2 pellets is reported. Insulator materials testing and fission gas venting experiments are described. Converter Development. Results of in-pile/out-of-pile converter testing and of sub-component testing are reported. Reactor Design and Analysis. Some converter cell concepts are discussed. Physics calculations were carried out on a thermionic reactor with zones of differing enrichment. (D.L.C.)

15490 (HW-79814) INTENSITY OF BETA RADIATION AT THE SURFACE OF A FUEL ELEMENT. D. R. Dickinson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 1964. Contract AT(45-1)-1350. 22p.

The problem of calculating the beta intensity at a fuel element surface is discussed and solved by summation of the contribution from each beta energy level from fission products. The net flux of beta particles through the fuel element surface and their rate of absorption at the surface, in terms of both number of particles and energy, are presented in graphs as function of the cladding thickness for a given specific power level within the fuel. As an example, a calculation is presented of the beta intensity at the surface of a PRTR fuel element. (auth)

15491 (ORNL-3523(p.103-26)) FUELED-GRAPHITE DEVELOPMENT. A. Goldman (Oak Ridge National Lab., Tenn.).

A method was developed for routine density determinations on pyrolytic-carbon coatings. The basic instrument used is a helium pycnometer. Crushing loads for pyrolytic-carbon-coated uranium carbide particles were shown to be dependent upon coating thicknesses. Examination of coated particles treated for 5½ hr at 1000°C in a 1:1 mixture of chlorine and argon revealed that 99.5% of the fuel was removed from UC_2 particles and 98% from $(U,Th)C_2$ particles. Laboratory-scale equipment was operated to apply pyrolytic carbon coatings to fuel particles. The following conclusions were drawn from observation of the products: (1) coating microstructure is dependent on the rate of application and is independent of pyrolysis temperature over the range 1400 to 1800°C, (2) deposition rates as high as 118 μ/hr produce no undesirable results, and (3) deposition rates vary with total gas pressure, methane partial pressure, and the amount of fuel charged. Samples of coated particles were microradiographed for nondestructive evaluation. Coating layers were readily evident, and thicknesses were compared with control samples fabricated from pyrolytic-carbon-coated 0.002-in.-dia. tungsten wires. Seven fission-product deposition tests were run on UC_2 particles. From available data it was surmised that the mechanism of deposition was chemical reaction with the deposition tube walls. The results of the studies indicate that the principal fission-product activities released at temperatures below 1000°C are iodine and xenon. The

principal mechanism of deposition appears to be two reactions with the tube walls; one reaction occurs at around 110°C and the other at about 320°C. Isostatic forming tests on pyrolytic-carbon-coated fuel particles in graphite indicated that pressures up to 7000 psi cause no damage to particles at loadings up to 21 vol %. Fuel plates were fabricated as standards in establishing densitometer techniques for evaluating radiographs. The plates contained 8.6 to 16.2 vol % pyrolytic-carbon-coated $(U,Th)C_2$ particles in graphite. Fueled-graphite spheres and cylinders were evaluated for surface contamination by physical cleaning and chlorine treatment. Ultrasonic cleaning in carbon tetrachloride reduced the alpha activity of the specimens to less than 50% of the original levels. The removal of $(U,Th)C_2$ fuel from damaged particles in the spheres required 16 hr, a significantly lower rate than the 2 hr required to remove UC_2 fuel from the graphite cylinders. Chlorination results were inconclusive. The possibility of using pyrolytic-carbon-coated B_4C particles in a graphite matrix as poison spheres for pebble-bed reactors was considered but abandoned because of possible excessive boron losses in actual reactor coolants. Studies were continued on rare-earth oxides and carbides. Lindsay Mix (45% Gd_2O_3, 45% Sm_2O_3, and 10% other rare-earth oxides) and Eu_2O_3 particles were prepared and coated with pyrolytic carbon. The compatibility of the rare-earth oxides and carbon was determined thermogravimetrically. Unsuccessful attempts to form spheroidal europia particles and rare-earth oxides are reported. (auth)

15492 (ORNL-3523(p.127-92)) INVESTIGATIONS OF FUELED-GRAPHITE SYSTEMS. O. Sisman, D. B. Trauger, H. W. Savage, and G. M. Watson (Oak Ridge National Lab., Tenn.).

Ten capsules containing unsupported UC_2 or $(U,Th)C_2$ particles with various types of coatings were examined. The particles were irradiated at temperatures of 1100 to 2300°F to burnups ranging from 2 to 19% of the heavy metal. The coatings were evaluated on the basis of fission-gas release, exposed UC_2 or $(U,Th)C_2$, which was removed by acid leaching, and microstructure, as determined by metallography. The fraction of particles with fractured coatings varied from 0 to 100%, depending on the type of coating and the irradiation conditions. Two types of capsules containing coated particles dispersed in graphite were examined. About half of the 36 hollow, cylindrical fuel bushings, which were irradiated to 8% uranium burnup at temperatures of 1700 to 2000°F, fractured during irradiation. Metallographic examination showed that large fractions of the particle coatings fractured, and there were indications that fractures in the graphite had caused some coating fractures. Sixteen fueled graphite spheres, which had been irradiated to 2 to 11% burnup of the heavy metal at temperatures of 1000 to 1500°F, were also examined. There were no visible fractures in the spheres, and changes in weights and diameters were very small. Gas analyses indicated that approximately 0.1% of the fission gas was released. Postirradiation high-temperature annealing studies were made on pyrolytic-carbon-coated uranium carbide particles irradiated to 30% uranium burnup. The Kr^{85} release rates were less than 3 ppm up to a temperature of 1600°C. Apparent coating failures indicated by bursts of gas release were less than 5% after 3 hr at 2100°C. Equipment was developed for examination and handling of the particles. Three miniature capsules containing coated particle fuels were irradiated in the LITR. Two of these capsules achieved the desired burnup and were removed. A fourth capsule was prepared for irradiation. A series of experiments involving uranium migration in porous graphite were completed for the temperature interval 1200 to 1700°C. Experimental procedures and data correlation methods were established, and diffusion parameters characteristic of the system studied were obtained. The results for uranium migration were in good agreement with thorium diffusion data. Unfueled spheres of Speer Moderator-2 graphite and fueled spheres from lots GA-S3, GA-S4, GA-S5, 3M-S2, 3M-S3, and 3M-S6 were reacted with a steam-helium mixture having a partial pressure of steam of approximately 730 mm (Hg) at temperatures from 800 to 1000°C. The activation energy was found to be 55 to 60 kcal/mole for all the spheres reacted with steam in this temperature range. An investigation of the adsorption behavior of fission-product iodine was undertaken. Exploratory experiments indicated that iodine reacts irreversibly with stainless steel surfaces to form metal iodides over the temperature range 25 to 700°C. A more rapidly desorbed component also is evident, usually to a lesser extent. The diffusional deposition method for determining diffusion coefficients of radioactive particles and vapors was utilized in investigating the nature and behavior of volatile iodine compounds. These were observed to occur, in certain situations, in conjunction with the elemental form. Composite diffusion tubes having, in the direction of flow, inner surfaces of silver, rubber, and, in one instance, activated carbon have shown the presence of two nonelemental species of iodine in addition to the elemental form. The compound or compounds which are retained by a rubber surface have an indicated diffusion coefficient in air of around 0.05 cm^2/sec, and those retained by activated carbon, about 0.10 cm^2/sec. These results together with data obtained by other means have provided clues to the identity of the iodine compounds, and further work is planned in order to identify them more explicitly. A method was developed for characterizing radioactive aerosols in terms of their response to the processes of diffusion, interception, and inertial impaction by determining their distribution versus depth in fibrous filters under carefully controlled conditions. The velocity dependence of the slope of the distribution curves on a semilog plot identifies the mechanism of filtration, and the magnitude of the slope indicates the intensity of the filtering action and thus the character of the particles. Experiments where diffusion is the controlling mechanism were treated quantitatively, and particle sizes in the 50 to 500 A range determined by this technique compare favorably with those obtained from concentration and flow data and electron photomicrographs. Four additional experiments were completed in the out-of-pile fission-product deposition loop at BMI. Three distinct patterns of plateout were observed; one that was typical for Te^{132}, one for Ba^{140}, La^{140}, Ce^{141}, Ru^{103}, and Zr^{95}, and one for I^{131}. Activities deposited in orifice sections were also studied. Samples of graphite, nickel, and carbon steel were exposed in the sweep gas downstream from the fuel sample in GCR-ORR loop No. 2. Preliminary data on fission-product deposition were obtained. The analytical model for fission-product deposition was extended to include time-dependent relations, and a computer code was written. The deposition of fission products from laboratory volatilized I^{135}, Ba^{140}, and Cs^{137} was studied and decontamination factors were obtained. Three sets of metal specimens exposed in reactor loop facilities were also studied. (auth)

15493 (ORNL-3523(p.193-226)) CLAD FUEL DEVELOPMENT. A. Goldman, O. Sisman, and D. B. Trauger (Oak Ridge National Lab., Tenn.).

A model was proposed for solutions to the problem of fuel element failure because of mechanical interactions of fuel and cladding. An equation was derived for determining the thickness of cladding required to prevent ratchetting during thermal cycling, and the use of lubricants at the fuel-to-cladding interface is being investigated. The results of in-pile and out-of-pile stress rupture tests on British 20% Cr–25% Ni–Nb-stabilized stainless steel illustrated marked differences for observed fracture strains. Out-of-pile tests in CO_2 plus 5 vol % CO and in argon plus 1 vol % O_2 at 850°C showed no significant differences attributable to the environment. Tests were conducted on types 304 and 347 stainless steel exposed to NaCl contamination because of the possibility that metal salt contamination caused the rapid intergranular deterioration of type 304 stainless steel in fuel element test assemblies irradiated in GCR-ORR loop No. 1 and subsequently stored in water in the ORR pool. The specimens were stressed and exposed for 1000 hr at 1100 and 1400°F in helium containing 1 to 2 vol % water vapor. Additional thermal conductivity tests of UO_2 at –67 to 1350°C showed an increase in thermal resistance with decreasing temperature, with the thermal conductivity of UO_2 passing through a maximum at 0°C. High-temperature runs above 1100°C revealed thermocouple errors that appeared to invalidate previously reported data obtained above this temperature. The results are consistent with the theory that heat in solids is transported primarily by phonons. A vented stainless steel-clad UO_2 fuel element and three wire-wrapped elements were tested in GCR-ORR No. 1. The release of noble fission gases from the vented element was about that predicted, and the time required to reach equilibrium was relatively short. This test demonstrated that the loop can be operated with considerable activity present. A study of the overall heat capacity of the loop indicated that 40 to 50 kw of heat can probably be removed compared with the original rating of 20 kw. Techniques were investigated for preparing spheroidal $(U,Th)O_2$ particles for incorporation into BeO matrices. Development studies were carried out to improve the distribution of fueled particles in a BeO matrix. Superior dispersions were achieved by dry-coating wet fuel particles with BeO powder. Studies were carried out to eliminate exposed fuel at specimen surfaces. Fuel particles are exposed during dry pressing even though individually coated. Leaching studies were performed on BeO bodies with 2M HNO_3 at 98°C. The addition of MgO to the fuel bodies reduced the rate of fuel loss, but further tests indicated that the MgO was rapidly dissolved in the acid. Additional leaching studies on coated BeO–UO_2 particles revealed that more fuel was leached from the thinner coated specimens apparently through flaws. No changes in microstructure, weight, or dimensions were noted after heating fueled BeO specimens out of pile at 1100°C in vacuum for approximately 3000 hr. A stainless steel capsule containing 27 vol % UO_2 as spheroidal particles in a BeO matrix in the form of hollow pellets was examined after irradiation in the ORR poolside facility to a burnup of approximately 7750 Mwd/MT of fueled specimen. The MgO sleeve surrounding the pellets was severely fractured, but the fueled BeO pellets were intact. The pellets showed swelling of 1% maximum. Microfractures were found in the pellets, and the UO_2 grain size in the central portions was three to four times that of the outer regions. The fission-gas-release characteristics of fueled BeO compacts were tested with excellent retention properties appearing for those particles coated with BeO prior to sintering. (auth)

15494 (SWRI-1321-1) NONDESTRUCTIVE ASSAY OF NUCLEAR FUELS. Quarterly Report No. 2, November 16, 1963–February 15, 1964. Warren J. McGonnagle and Raymond R. Nydegger (Southwest Research Inst., San Antonio). Feb. 24, 1964. Contract AT(11-1)-1321. 8p.

The Compton spectrometer and solid state detectors are evaluated for use in assaying unirradiated and irradiated fuel elements, and methods for nondestructively assaying scrap materials are discussed. Three types of Compton spectrometers are investigated. All three types are inefficient as gamma detectors for fuel analysis when in-pile fission products are monitored. Neutron activation analysis monitoring of short half-lived fission products may be possible. Solid state detectors with energy resolutions of approximately 0.6% may have a high enough detection efficiency for fuel analysis. Possible methods of scrap analysis are x-ray transmission, neutron transmission, neutron production, and neutron activation analysis. (auth)

15495 (TRG-Report-636) TEMPERATURE DISTRIBUTIONS IN S.G.H.W.R. FUEL PINS: BOILING ZONE. B. E. Broome (United Kingdom Atomic Energy Authority. Reactor Group, Springfields, Lancs, England). 1964. 13p.

The effects of flux tilt and varying eccentric fuel can gaps upon the temperature distribution in SGHWR fuel pins are investigated. Calculations are performed for a peak rating and for an average rating and estimates are arrived at for fuel center temperatures and the diametral temperature drop across the fuel can. The latter figure is significant in estimating the thermal bowing. (auth)

15496 (AEC-tr-6329) THE FUEL CYCLE IN FRANCE FOR THE SYSTEM OF NATURAL URANIUM–GRAPHITE–GAS REACTORS. R. Boussard, G. Jeanpierre, M. Monteil, and M. D. Martin. Includes: FRENCH INDUSTRIAL POLICY FOR THE PRODUCTION OF FUEL ELEMENTS FOR THIS SYSTEM, pp.32-47. R. Boussard and M. Monteil. Translated for Oak Ridge National Lab., Tenn., from a paper presented at the "Colloquium of the European Society of Atomic Energy, [Fuel Cycles for Power Reactors], Baden-Baden, September 9-14, 1963." 48p.

The results of studies conducted on fuels for the natural uranium–gas–graphite reactors are presented. Properties of the fuel and the cladding material and the fuel element geometry were investigated. II. The industrial policy of the C.E.A. and the economic aspects of industrial manufacture are outlined for the production of fuel elements for the natural uranium–gas–graphite reactors. (C.E.S.)

15497 (EURAEC-536) RESEARCH ON VIBRATION AND HEAD LOSSES INSIDE TUBE BUNDLES. Quarterly Progress Report No. 9, October 1–December 31, 1962. (Société Grenobloise d'Etude et d'Applications Hydrauliques, Grenoble, France). Jan. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 083-62-1-RDF. 3p. (A translation)

The vibrations and head losses inside reactor fuel element clusters are investigated in a parallel flow test loop, and the results obtained are analyzed. (N.W.R.)

15498 (EURAEC-596) THEORETICAL AND TECHNOLOGICAL STUDY ON NUCLEAR FUELS BASED ON COMPOSITE REFRACTORY PELLETS. Quarterly Report No. 4, October 1, 1962–December 31, 1962. (Compagnie pour l'Étude et la Réalisation de Combustibles Atomiques, Bonneuil-sur-Marne, France). Work Performed under United States–Euratom Joint Research and Development Program. Contract 77-61-12 RDF. 112p. (A translation)

A comparison between evolutions in time of the reactivities of a standard homogeneous fuel and those of a composite fuel showed, at the same power level, a tangible advantage in favor of the latter. The presence of two elements that absorb neutrons by resonance resulted in a decrease in the initial value of the multiplication factor. This phenomenon was compensated by an abatement of the reactivity variation in time. It seemed thus possible to increase the burnup by more than 40% for an unchanged initial quantity of U^{235}. The conversion factor for composite pellets was not better than with standard fuels. The life gain observed was due to the fact that thoria was used as a compensation material during the initial phase of operation. The power increase that may be expected is limited by the critical temperatures in uranium oxide and thoria and dependent on lattice design, burnup, and initial enrichment. (M.C.G.)

15499 (EURAEC-649) THEORETICAL AND TECHNOLOGICAL STUDY OF NUCLEAR FUELS BASED ON COMPOSITE REFRACTORY PELLETS. Final Report No. 1, December 15, 1961 to January 31, 1963. J. Doumerc, R. Hauser, and G. Troccon (Compagnie pour l'Etude et la Realisation de Combustibles Atomiques, Bonneuil-sur-Marne, France and Compagnie Industrielle des Combustibles Atomiques Frittes, Corbeville, par Orsay (Seine-et-Oise), France). Work Performed under United States–Euratom Joint Research and Development Program. Contract 77-61-12 RDF. 119p. (A translation)

A nuclear fuel composed of composite pellets in which a fissile material (UO_2) in annular form is arranged around a fertile nucleus (ThO_2) is evaluated. This peripheral arrangement of the UO_2 permits to reduce the thickness of the refractory material that separates the innermost heat sources from the cooled surface, and while maintaining the temperature of the inner face of the UO_2 below the critical value, makes it possible to increase the heat flow on the surface of the fuel and hence its specific rating. During operation, fissile material (U^{233}) and heat sources develop within the thoria, tending to stabilize the rating, whereas the uranium at the periphery becomes gradually depleted and temperature rises decrease. This heterogeneous arrangement considerably increases the aptitude of the association of the two elements U^{233}–Th^{232} for reducing the variation in reactivity in the course of time and obtaining high depletion rates without any excessive initial reactivity. The sibstitution of such a fuel for a UO_2 fuel could result in a 40% increase in rating and a 25% cut in the kwh cost with a depletion rate of 20,000 HWJ/t. Fabrication tests with composite pellets were concerned with the fitting of crude UO_2 on sintered ThO_2 and gave encouraging results. During preliminary hot stability tests the pellets showed that UO_2–ThO_2 diffusion is very low and that thermal resistivity on contact with both elements is negligible. The process is expensive and it would be interesting to resume the tests according to some other methods which would not require more than one sintering. Encouraging experiments were performed to adjust the shrinkage of the two components. (auth)

15500 (NP-tr-1111) IMPROVEMENTS TO FUEL ELEMENTS. M. Gauthron, M. Salesse, and J.-A. Stohr. Translated by J. B. Sykes (U.K.A.E.A. Research Group, Atomic Energy Research Establishment, Harwell, Berks, Eng.), from French Patent 1,323.725. Mar. 2, 1962. 8p. (Handwritten MS Copy)

A uranium carbide-based reactor fuel element is described which allows the attainment of higher temperatures and power densities. The fuel element comprises a UC, UC_2, or UC–UC_2 core, a very thin (<0.3 mm thick) sheath of a Fe–Al alloy containing 13 to 40% Al, and radial centering struts for bearing on the channel wall. The fuel and sheath materials may also contain small additions of various substances, and there may be a separating layer between the fuel and sheath. (D.L.C.)

15501 CHARACTERISTICS AND BEHAVIOR OF HIGH-TEMPERATURE NUCLEAR FUELS. Hj. Matzke and R. Linder (Technische Hochschule, Braunschweig, Ger.). Atomkernenergie, 9: 2-46(Jan.-Feb. 1964). (In German)

The state of research in the field of ceramic nuclear fuels, especially as far as basic studies are concerned, is elucidated. Besides uranium dioxide, uranium carbide and other compounds of uranium and thorium for high temperature use are considered. Recent experiences in the USA on the behavior of ceramic fuel at high burnup are reviewed. A discussion is presented on questions of atomic mobility (diffusion) in ceramic fuels. Some lines of possible future research are indicated. (auth)

15502 DANCOFF CORRECTION FOR SPHERICAL FUEL ELEMENTS. K. Donat (Institut für Reaktorentwicklung, SGAE, Vienna). Atomkernenergie, 9: 61-3 (Jan.-Feb. 1964). (In German)

The Dancoff correction factor for mutual shielding was calculated for the case of two fuel spheres. By use of the usual physical assumptions and by introduction of an approximation, a correlation was derived, which requires only a small amount of time for a numerical evaluation. The results are presented in a diagram. (auth)

15503 THE FRENCH NUCLEAR INDUSTRY AND REACTOR DEVELOPMENT. THE IMPROVEMENT OF METALLIC FUEL ELEMENTS IN POWER REACTORS OF THE GRAPHITE–CARBON DIOXIDE TYPE. M. Saulnier. Atompraxis, 9: 523-6(Nov.-Dec. 1963). (In French)

The technological, metallurgical, and mechanical problems in the fabrication of uranium rods, fuel elements, and special elements (assemblies to be tested under irradiation) are described. (J.S.R.)

15504 THE FRENCH NUCLEAR INDUSTRY AND REACTOR DEVELOPMENT. FABRICATION OF REACTOR FUEL ELEMENTS. M. Aragou. Atompraxis, 9: 527-31 (Nov.-Dec. 1963). (In French)

The fabrication processes studied and perfected in France are described. The characteristics of the principal fuel elements now in use or to be used in France are briefly reviewed. The fabrication processes discussed are vacuum casting of uranium, cladding by hydraulic or pneumatic working, and electron welding. (J.S.R.)

15505 ANALYSIS OF THE FUEL CYCLE. Raymond L. Murray (North Carolina State Coll., Raleigh). Comit. Nazl. Energia Nucl., Notiziario, 9: No. 12, 44-51(Dec. 1963). (In Italian)

Methods for the analysis of fuel cycles in different reactor types are given. The behavior of a reactor with highly enriched U^{235} fixed fuel is first examined in order to describe the basic characteristics of this method. Natural uranium or low-enrichment systems in which many isotopes are consumed and produced are then considered. The relationships among operation with fixed fuel, with rearranged fuel, and with continuous mixing are also discussed. (auth)

15506 A SIMPLIFIED ANALYTICAL METHOD FOR PREDICTING THERMAL NEUTRON SPECTRA IN COMPOSITE FUEL ELEMENTS. R. Bonalumi (Laboratori CISE, Milan). Energia Nucl. (Milan), 11: 1-8(Jan. 1964).

An approximate method was devised to allow rapid, even if approximate, calculations of the thermal neutron spectra in a composite fuel element. The method is based on transport considerations and an approximate expression of the thermalization sources. It is an extension of previous work. A few comparisons with experiments were encouraging, despite the intrinsic approximations made in computations. (auth)

15507 IN-PILE EXPERIMENTS ON MELTDOWN OF EBR-II MARK I FUEL ELEMENTS IN STAGNANT SODIUM. C. E. Dickerman, E. S. Sowa, J. H. Monaweck, and A. Barsell (Argonne National Lab., Ill.). Nucl. Sci. Eng., 18: : 319-28(Mar. 1964).

Experiments were performed in-pile, using the Transient Reactor Test Facility, to study the meltdown behavior under transient heating of metallic Experimental Breeder Reactor-II fuel elements contained in stagnant sodium. Threshold of failure, modes of failure, and post-experiment distribution of fuel were obtained for a range of experimental conditions including uniform axial power and axial-power profile shaped to approximate a typical power profile of a fast-reactor core. Samples were exposed both with sodium initally at saturation conditions, and with sodium pressurized to inhibit boiling. Although the presence of stagnant sodium was found to modify qualitatively the results found previously for dry EBR-II samples, the changes were not great, and results were consistent with those for dry elements. (auth)

15508 AN EIGENVALUE METHOD FOR THE CALCULATION OF NUCLEAR BURNUP. G. D. Joanou, J. R. Triplett, and R. M. Wagner (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 18: 363-9(Mar. 1964).

An iterative approach to the reactor burnup problem is developed on the basis of analytical solutions for the variable-coefficient burnup equations. The time dependence of the depletion matrices, A(t), is approximated by a polynomial representation. The number of basic time points for which spatial-diffusion calculations during burnup are required is determined only by the order of approximation necessary to give a reasonably good fit for the time dependence of A(t). Usually a low-order approximation is sufficient, so the number of diffusion calculations is reduced to a minimum. The method is applicable both to survey-type calculations and to detailed reactor-burnup studies. A comparison of some results obtained with the method described and with standard calculational methods is given. The results show the rapid convergence and accuracy of the proposed procedure. (auth)

15509 PLATE FUEL ELEMENT ASSEMBLY FOR A NUCLEAR REACTOR. Jackson S. Neal (to Martin-Marietta Corp.). U. S. Patent 3,124,515. Mar. 10, 1964. Filed Oct. 16, 1959.

A plate-type fuel assembly is described in which the elements are held in place by grooves and compound dovetail keys, thus eliminating disadvantages of brazing. (R.E.U.)

Power and Power-Breeder Reactors

15510 (ACNP-6011) OPERATING CONTROL RODS FOR THE ENRICO FERMI ATOMIC POWER PLANT. Final Design Report. R. J. Grenda and M. A. McDermott (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Nov. 8, 1960. For Atomic Power Development Associates, Inc., Detroit. 29p.

The final design of the operating control rods for the Enrico Fermi Atomic Power Plant was completed. Two such rods are located near the center of the reactor, which is sodium cooled. Boron carbide is used as poison material. A flow distribution test and analysis, thermal analysis, and stress analysis of the rod were performed for both the normal operating and scram conditions. The test and analysis show that the design meets APDA specifications. (auth)

15511 (ACNP-62548) RECYCLE OF REACTOR FUEL. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). May 1962. 25p.

A preliminary design for an integrated nuclear power station consisting of a 300-Mwe boiling-water power plant (fueled with thoria-urania rods) and a complete reprocessing and refabrication facility is presented. The economics of the thorium cycle are discussed and compared with those of a uranium cycle. Operation of the station is also outlined. (D.C.W.)

15512 (ACNP-63605(Rev.1)) ELK RIVER REACTOR OPERATIONS ANALYSIS PROGRAM. Semiannual Progress Report, January 1, 1963–June 30, 1963. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Oct. 4, 1963, Revised Jan. 1964. Contract [AT(11-1)-654]. 83p.

Low power test operation of the reactor was begun. Experimental reactor data were used to normalize analytical models. These models will be employed in the analysis of operational characteristics and in core management studies. The methods used in obtaining desirable analytical models are discussed. Performance of the plant energy transfer system, with the use of the emergency and test condenser (E&T) as a heat sink, was generally satisfactory. There were no apparent instabilities of the reactor and condenser. The most time consuming problems during test operation were small steam leaks in the primary system valves. Data for evaluation of corrosion effects on the system will be provided by water analyses. The performance of the primary auxiliary systems was satisfactory. The reactor and auxiliaries are described. (auth)

15513 (ACNP-64004) PATHFINDER ATOMIC POWER PLANT. ALUMINUM CLAD BOILER FUEL CAPSULE IRRADIATION. D. A. Patterson and D. A. Nehrig (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Feb. 20, 1964. For Northern States Power Co., Minneapolis and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. 71p.

Twelve aluminum-clad fuel specimens were irradiated to burnups ranging from 2,480 to 13,240 MWD/ton-U and examined. The fuel specimens contained 95% dense UO_2 pellets clad with draw-bonded 8001 aluminum alloy. The maximum clad temperatures varied from 450 to 900°F. The peak heat ratings varied from 37 to 78 W/cm. Post-irradiation examination revealed clad failures in five of the twelve fuel specimens. Two specimens failed by collapse of the fission gas spacer. The other three specimens experienced clad penetrations. The cause of the penetrations was not determined. Some swelling of the fuel was experienced by two specimens. The fission gas release varied from 0.05 to 5.6%. Metallographic examination revealed grain growth in only two of the fuel specimens. (auth)

15514 (ACNP-64005) PATHFINDER ATOMIC POWER PLANT. Technical Progress Report, October–December 1963. (Allis-Chalmers Mfg. Co. Atomic Energy Div.,

Milwaukee). Feb. 25, 1964. For Northern States Power Co., Minneapolis and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. 33p.

Progress is reported on the development of the Sioux Falls Power Reactor. Information is included on: samarium transient behavior, pre- and post-critical testing, physics tests, boiler fuel element criticality requirements, and core design. (N.W.R.)

15515 (CEA-Bib-39) LES ACIERS DE CAISSONS ET DE CUVES DE RÉACTEURS DE PUISSANCE. (Steels Used for Power Reactor Pressure Vessels). Marcel Jean (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 31p.

The steels used for pressure vessels of power reactors respond to specifications and to laws which are examined and defined. The reactors in existence, or projected, are reviewed in order to point out the various qualities of steels which were, or are being used; the qualities planned for the near future are examined. Two characteristics peculiar to steels used for pressure vessels can be added to the criteria of boiler quality steels; these are in particular those concerning the impact test and the ductile-brittle transition temperature, on the one hand, and creep properties on the other. Other characteristics such as, for example, the corrosion resistance of steels used in gas-cooled, or liquid metal-cooled reactor pressure vessels, are also considered. (auth)

15516 (CONF-243-48) REACTIVITY CONTROL PROBLEMS IN THE PLUTONIUM-FUELED EBR-I REACTOR. R. O. Haroldsen, F. D. McGinnis, and R. R. Smith (Argonne National Lab., Ill.). [1967]. Contract [W-31-109-eng-38]. 11p.

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The delayed neutron fraction, prompt neutron lifetime, and excess reactivity requirements of the EBR-I are discussed. (C.E.S.)

15517 (CVNA-199) THE DEVELOPMENT OF PERIODIC, NON-DESTRUCTIVE INSPECTION TECHNIQUES, PROCEDURES, AND TRANSDUCERS FOR CVTR PRESSURE TUBES AND THERMAL BAFFLES. E. Paxson and E. T. Hughes (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Feb. 1964. For Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C. Contract AT (30-1)-2289. 160p.

The objectives, development, conclusions, and recommendations of an AEC sponsored research and development program to develop and determine periodic, non-destructive inspection techniques, procedures, and transducers for Carolinas Virginia Tube Reactor pressure tubes and thermal baffles are given. The program was to establish and specify the minimum number of inspection operations during the periodic refueling of the reactor and to develop the equipment and inspection procedures necessary to ensure a high degree of pressure tube and thermal baffle reliability. The principal inspection techniques specified and developed are ultrasonic inspection to detect defects in the straight Zircaloy portion of the CVTR pressure tubes, and visual inspection to detect defects in the pressure tube surfaces, the reusable thermal baffle surfaces, the Conoseal gasket seats, and the pressure tube ball-cone seat. The ultrasonic inspection development program included the test type determination, the transducer development, inspection procedure and design of equipment to move the ultrasonic transducers over the surface of the pressure tube. The final method provides better than 3% test sensitivity by means of an immersed, double reflection technique utilizing cylindrically focused 5 Mc ultrasonic transducers. The visual inspection development included the specification of a multipurpose borescope and an underwater viewer. The development of a vacuum drying technique is described for drying the pressure tubes of both light and heavy water during the refueling operation. Finally, the design of a group of special tools to aid in the vacuum drying operation and ultrasonic inspection is given. (auth)

15518 (CVNA-200) MONTHLY OPERATING REPORT. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). January 1964. Contract AT(30-1)-2289. 36p.

Due to the chloride-fluoride contamination problem, it was decided to remove the insulation from the header cavity and install new mirror-type insulation. This insulation is made up of layers of stainless steel sheets that are enclosed within a stainless steel box. The reactor was operated, after the insulation was removed, for the completion of the low power, low temperature portions of the reactor physics test, S.U. CV-45, "Moderator temperature coefficient, primary coolant temperature coefficient, primary coolant pressure coefficient." A vapor container leak rate test was performed during the physics test and some leakage was found. Repair work was done to reduce this leakage. The vapor container will be retested. A checkout of the Refueling Machine and other refueling equipment was made. The spent fuel pit and transfer canal were filled with demineralized water in preparation for a wet checkout of the refueling system. (auth)

15519 (DLCS-5000164) MONTHLY OPERATING REPORT [ON SHIPPINGPORT OPERATIONS], JANUARY 1964. (Duquesne Light Co., Shippingport, Penna.). Contract AT(11-1)-292. 61p.

The operating performance and activities occurring at the Shippingport Pressurized Water Reactor are summarized. Information is reported on operation statistics, health physics, fueling, chemistry, maintenance, test program, training program, construction and modifications, and incidents occurring. (N.W.R.)

15520 (DP-895) HEAVY WATER MODERATED POWER REACTORS. Progress Report, January–February 1964. R. R. Hood, comp. (Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.). Mar. 1964. Contract AT(07-2)-1. 32p.

The HWCTR was operated most of January for irradiation tests of fuel assemblies. The reactor was shut down early in February for repair of a D_2O leak in one of the steam generators. The D_2O loss during reactor operation in January averaged 14 pounds per day, which is equivalent to the annual loss of 7% of the inventory. An assembly of compacted UO_2 tubes was undamaged by irradiation to 10,000 Mwd/tonne in the HWCTR; the free-gas content of the tubes was somewhat lower than expected. Two Zircaloy-clad tubes of unalloyed uranium exhibited large local decreases in outer diameter during irradiation to 7,000 Mwd/tonne. Experimental data were obtained on heat-flux limits for water flow in tubular channels at 750 to 1500 psia. Burnout measurements were made on single tubes and on three tubes connected in parallel to a common coolant supply. (auth)

15521 (DPR/INF/273) EXPERIENCE WITH FAST REACTORS. John Cockcroft (United Kingdom Atomic Energy Authority, London). Dec. 1963. 10p.

The interest in fast reactors is indicated; and the design, construction, operation, experimental program, and performance of the Dounreay fast reactor are summarized. (D.C.W.)

15522 (GAMD-3513) SUMMARY OF NUCLEAR ANALYSIS RESULTS FOR A REFERENCE DESIGN 40-Mwe HTGR. P. U. Fischer, M. H. Merrill, and K. R. Van Howe (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Apr. 25, 1963. Contract AT(04-3)-314. 66p.

Analytical results obtained for a typical reference design of a 40-Mw(e) HTGR are summarized. Topics included are lifetime studies, control rod worth, temperature coefficient, and reactor kinetics. (C.E.S.)

15523 (GEAP-4363) EVESR-NUCLEAR SUPERHEAT FUEL DEVELOPMENT PROJECT FIFTH QUARTERLY REPORT, JUNE–AUGUST 1963. R. T. Pennington (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Sept. 1963. Contract AT(04-3)-189. 109p.

The status of EVESR is described. The design, fabrication, and tests of the EVESR fuel are described along with the fuel evaluation instrumentation. The initial fuel loading was completed with the exception of two instrumented bundles. (D.L.C.)

15524 (HW-76008) TESTS ON REACTOR HELIUM SEALS—PRTR INLET. D. H. White (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1963. Contract AT(45-1)-1350. 19p.

A series of developmental tests on five types of high-temperature static gas seals is described. These seals were designed for a helium system operating at a pressure of 4 in. of mercury and 480°F. Tests of a Zircaloy-2, stainless steel joint helped define the mechanism of leakage and proved the advantage of certain types of seal designs. The seals tests were designed for a specific application on the Plutonium Recycle Test Reactor to reduce helium losses from the dry gas system of the reactor, but are of potential use as static gas seals for any gas system operating under similar conditions. (auth)

15525 (HW-78456) PRTR ZIRCALOY-2 PRESSURE TUBE SURVEILLANCE PROGRAM—ITS HISTORY AND UTILITY. M. C. Fraser (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 10, 1963. Contract AT(45-1)-1350. 32p.

A description of the PRTR Zircaloy-2 pressure tube surveillance program and a summary of the information collected are presented. Information and data that accrued under the existing charter of the program showed that: creep of the tubes in-reactor is not occurring, the hoop strength is sufficient for the tubes in-reactor to sustain about 3 times the PRTR operating hydrostatic pressure, the tubes in-reactor appear to have a low notch sensitivity, about one in every five fret marks studied had abnormal hydride concentrations, there was no case where a hydrided fret mark reduced the load capacity of a burst test specimen, cold-worked portions of the tubes appeared unable to arrest a traveling crack whereas annealed portions were capable of arresting a traveling crack, and the PRTR environment changes the annealed material properties in the direction of the cold-worked material properties. It is proposed that the scope of the destructive examination portion of the PRTR surveillance program be changed to a minimum tube discharge rate of one tube every 90 days at rated power rather than one tube per operating month. (auth)

15526 (NAA-SR-Memo-9369) ANALYSIS OF EXCESS REACTIVITY MEASUREMENTS IN THE HNPF. F. L. Fillmore and J. M. Zetterbaum (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1963. Contract AT-11-1-GEN-8. 16p.

During the loading of the Hallam Power Reactor fuel from wet critical to the operational loading of 140 fuel elements, measurements were made of the excess reactivity that was added. It was recongized that the total excess reactivity loaded is not correctly given by summing the excess added in each loading increment. The reasons for this are the increase in core size as more fuel is added and the flux perturbation caused by the insertion of control rods to hold down the excess already loaded. Corrections to the measured values were calculated by perturbation theory. The resulting curve for total excess reactivity as a function of the number of fuel elements loaded shows good agreement with previous calculations of the excess reactivity using few group theory. (auth)

15527 (NP-13723) FACT BOOK ON U. S. NUCLEAR POWER PROJECTS. Fifth Edition. (Bozell and Jacobs, Inc., New York). July 1963. 79p.

A collection is presented of background information on the development of nuclear electric power in U. S. and of fact sheets on all U. S. power reactor projects. The fact sheets are arranged under the reactor types: water-cooled, sodium-cooled, organic-cooled, and gas-cooled. (D.L.C.)

15528 (NYO-9788) SURVEY OF COMPONENT REQUIREMENTS AND AVAILABILITY FOR GAS-COOLED NUCLEAR REACTOR POWER PLANTS. VESSELS AND SUPPORTS, VALVES, EXPANSION JOINTS, AND PIPES. Georgs Novickis (Franklin Inst. Labs. for Research and Development, Philadelphia). Oct. 1962. Contract AT(30-1)-2512. 697p. (I-A2392-3)

The state of the art in design requirements and availability of reactor pressure vessels and supports, valves, expansion joints, and piping for primary circuits in gas-cooled reactors are assessed. Seventy-nine reactors are listed. The above mentioned equipment for these reactors is described and discussed, and lists of manufacturers are included. (auth)

15529 (ORNL-3503) DESIGN AND THERMAL ANALYSIS OF EGCR CONTROL RODS. J. W. Michel (Oak Ridge National Lab., Tenn.). Mar. 1964. Contract W-7405-eng-26. 56p.

Control rods were designed for use in the Experimental Gas-Cooled Reactor that are sufficiently flexible to move in bowed graphite channels. The stainless steel-clad B_4C bushings that make up the control rods are suspended on cables connected to the drive mechanisms. The rods are cooled internally by helium admitted at the top of the control rod nozzles. Tests of a mockup of a control rod verified the feasibility of assembly and provided pressure drop data. No major manufacturing problems were encountered and the finished rod weights varied from 137 to 142 lb. (auth)

15530 (ORNL-3523) GAS-COOLED REACTOR PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1963. (Oak Ridge National Lab., Tenn.). Jan. 29, 1964. Contract W-7405-eng-26. 493p.

Separate abstracts were prepared for each of the 12 sections of the report. (R.E.U.)

For abstracts of individual sections see: 13998, 14032, 14374, 14538, 15491, 15492, 15493, 15531, 15532, 15533, 15534, and 15535.

15531 (ORNL-3523(p.3-39)) PERFORMANCE ANALYSES. A. M. Perry, G. Samuels, and W. B. Cottrell (Oak Ridge National Lab., Tenn.).

Calculations of the physics of reflected reactors based on a number of new techniques were compared with experimental measurements made with the Physical Constants Test Reactor (PCTR) at Hanford and experimental information obtained in the United Kingdom in support of the design of the AGR. The accuracy of the physics calculations made during the design of the EGCR was judged by comparison with data obtained with the PCTR. The new comparison showed good agreement. Estimates were made of the flux distributions and resulting count rates to be expected during the first approach-to-critical experiment in the EGCR. The results indicated that the source geometry did not present any problem in the experiment and that ample count rates would be available. Estimates were also made of the number of fuel channels that must be loaded in the EGCR to achieve criticality with various numbers and groupings of control rods inserted. The multiplication factor of the fully loaded core with selected control rods fully withdrawn was calculated. The effect of air poisoning was included in these calculations. A study of the prompt neutron lifetime in a partially loaded core was also made. Studies were made of the effect of primary system ruptures when the EGCR is pressurized with air or nitrogen. If the rupture occurs when the core is pressurized to 20 atm., the multiplication factor will increase to k_{eff} = 1.0464 for the release of air and to k_{eff} = 1.0593 for the release of nitrogen. The reactor transients that would accompany the pressure releases are being studied. A new method was developed for studying the transient response of a reactor to a pulsed neutron source. The new method is applied to a study of the EGCR. The pressure loss through an actual EGCR control rod was measured to determine the validity of measurements made with the mock-up rod. The measured pressure drop was about 10% less than that obtained with the mock-up rod, and the relative position of the rod in the channel was not important. The temperature distribution through the control rods was recomputed using a more conservative graphite-channel temperature profile and computational refinements. The calculated maximum stainless steel cladding temperature was reduced from 1535 to 1475°F for a rod emissivity of 0.6. The relative thermal performance of the EGCR fuel elements was examined using carbon dioxide as the primary coolant. Data on the thermal and dynamic performance with CO_2 coolant are presented. Core cooling requirements in the event of the maximum credible accident were re-evaluated. Three periods were considered; the first hour after the reactor is scrammed and the core is exposed to air, the time a main blower is operated to cool the core with air, and the time the emergency cooling loop is used to cool the core. (auth)

15532 (ORNL-3523(p.40-58)) COMPONENT DEVELOPMENT AND TESTING. (Oak Ridge National Lab., Tenn.).

Progress on the fabrication of the EGCR main coolant blowers and the pressure-vessel cooling-system compressors is reported. Difficulties were encountered that required modifications of the shaft seal. An experimental test facility was built for studying steam–graphite reactions. Specimens can be tested over a temperature range of 1000 to 1800°F at system pressures up to 450 psig and steam flow rates up to 120 lb/hr. In an initial experiment, a graphite sleeve of an EGCR fuel assembly had a weight loss of 350 grams. The surface at the inlet end was powdered to a depth of $\frac{1}{8}$ inch, and the outlet end was only slightly pitted. Data on the production of hydrogen, carbon monoxide, and carbon dioxide are given. Three of four instrumented fuel assemblies being prepared for irradiation in EGCR are shown in completion up to the shield plug. Oxalic acid–hydrogen peroxide solutions containing fluorides were found to be useful for decontaminating stainless steels exposed to high-temperature contaminated helium. No stress-corrosion cracking was observed on U-bend specimens. (auth)

15533 (ORNL-3523(p.59-68)) MATERIALS DEVELOPMENT. A. Goldman (Oak Ridge National Lab., Tenn.).

A standard capsule for irradiation in the ORR poolside facility and five instrumented fuel elements for irradiation in GCR-ORR loop No. 1 were fabricated, the standard capsule containing Westinghouse EGCR-production UO_2 fuel bushings. The instrumented fuel assemblies have roughened surfaces. An ultrasonic "ringing" technique was developed for evaluating the bonding of brazed joints between the thermocouples and the inner surface of the cladding of instrumented fuel assemblies. An investigation was made of the effects of the vapor-phase corrosion inhibitor VPI-260 when allowed to enter the reactor. This material is being considered for protection of EGCR components during storage. No harmful effects were detected after 1000 hr of exposure at 1050°F of AISI 1020 steel and type 304 stainless steel to VPI-260 crystals and impure helium containing the decomposition products of the crystals. Fuel assembly fabrication is reported. An eddy-current technique was developed for the measurement of interrod spacing in the fuel assemblies and was used by ORNL inspectors at Westinghouse. This technique is also being used for measurements on instrumented fuel assemblies. Ten archive samples of different EGCR fuel blends were tested for fission-gas release. All release rates were below the maximum limit. Brazed fuel element tubes were subjected to stress-rupture testing with expected results. (auth)

15534 (ORNL-3523(p.276-360)) DEVELOPMENT STUDIES FOR AVR—GERMAN PEBBLE-BED REACTOR. B. L. Greenstreet, A. M. Perry, A. Goldman, G. Samuels, W. O. Harms, O. Sisman, and D. B. Trauger (Oak Ridge National Lab., Tenn.).

Fuel element development for the high-temperature gas-cooled "pebble-bed" reactor now being built near Julich, Germany, is reported. The fuel elements are nominally 6-cm-dia. graphite spheres containing about 5 wt % heavy metal (U + Th). One reactor fuel loading requires 100,000 spheres. The fueled-graphite spheres have machined unfueled graphite shells. Fuel composition and fuel management studies were made, with the temperature coefficient, control rod worth, and reactivity lifetime being considered. Burnup calculations showed that the burnup attainable in two full-power years is determined largely by the initial thorium-to-uranium ratio of the fuel. Lower thorium-to-uranium ratios give a greater initial reactivity and hence a longer burnup period before additional fuel is required. The nominal coolant, fuel element surface, and fuel element central temperatures were determined for several possible fuel element designs and reactor operating conditions. Calculations were made of the effect of thermal radiation to barren spheres on the surface temperatures of the fueled spheres. Experimental studies are being conducted for determining the thermal-shock resistance of solid graphite spheres and molded-shell fueled spheres. The characteristics of graphite spheres 2.36 and 1.5 in. in diameter were compared to determine their relative abilities to withstand impact. Analytical studies were conducted to examine the thermal stresses generated in a two-region

2.36-in.-dia. fueled-graphite sphere at reactor operating conditions. Tests used to determine the abrasion resistance of the spheres are discussed. Crushing strength and impact resistance were determined for five grades of graphite using 1.5-in.-dia. spheres. The molded grades exhibited superior performance in crushing tests, while the extruded grades withstood more impact. Density determinations made on 70 spheres prior to drop weight and crushing tests revealed no correlation between density and behavior in impact and crushing. Fueled spheres representing variations in geometry and supplies were crushed between steel plates to determine mechanical properties. The integrity of the coated particles in the fueled spheres was determined by acid electrolysis and neutron activation. The amount of internally exposed fuel varied from 2×10^{-3} to 16.5%, while Xe^{133} release varied from 2×10^{-4} to 1.1%. A mechanism was constructed for scanning 2.36-in.-dia. spheres for surface defects using a rotating fixture and a phase-sensitive eddy-current instrument. Radiographic techniques were devised that are capable of detecting 0.040-in.-dia. porosity, and 174 graphite spheres were examined. Infrared techniques are being investigated as a possible method of locating laminations within graphite spheres. The best fabrication scheme for AVR spheres was studied from irradiation tests on spherical fueled-graphite elements containing $(U,Th)C_2$ pyrolytic-carbon-coated particles. Experiments were also conducted in GCR-ORR loop No. 2 to determine fission-product release, transport, and deposition under simulated AVR conditions. Thermal conductivities were calculated from the heat balance data for fueled-graphite spheres having central-fuel thermocouples. (auth)

15535 (ORNL-3523(p.361-413)) STUDIES OF ADVANCED SYSTEMS. M. Bender, A. M. Perry, B. L. Greenstreet, and J. C. Suddath (Oak Ridge National Lab., Tenn.).

A study of combined gas turbine-steam turbine power cycles for use with gas-cooled reactors with gas temperatures up to 1500°F including design and cost estimates of equipment for two versions of 1000-Mw(e) power plants is reported. The characteristics and performance of fast gas-cooled reactors with plutonium oxide as fuel, $U^{238}O_2$ as fertile material, and helium or SO_2 as coolant are discussed. A parametric study of the fuel-cycle costs of fueled-graphite reactors was made. The U^{235}-thorium cycle and a coolant volume fraction of 0.4, which would be characteristic of a large pebble-bed reactor, were used. The principal variables considered were fuel composition, power density, neutron leakage, type of fuel feed, and fuel fabrication and reprocessing cost. Single-nozzle to spherical-shell attachments data using gages of $\frac{1}{22}$ in. length are reported. An aerosol spectrometer used to determine concentration and size distribution of particles in the gas stream of a gas-cooled reactor is discussed. (auth)

15536 (ORNL-3560) OUTGASSING BEHAVIOR OF EGCR MODERATOR GRAPHITE. J. P. Blakely and L. G. Overholser (Oak Ridge National Lab., Tenn.). Feb. 1964. Contract W-7405-eng-26. 45p.

The outgassing characteristics of specimens of the EGCR moderator graphite stock were determined in vacuo to a maximum temperature of 1000°C using external resistance heating and to 1800°C by induction heating. The specimens examined were cut from several locations in two of the 18-in. × 18-in. × 20-ft graphite bars which had been prepared under fabrication conditions comparable to those used for the graphite columns present in the Experimental Gas-Cooled Reactor. Data are given which show the effect of the position of sampling of the bars on the density of the graphite. The volume and composition of desorbates obtained at 300, 600, and 1000°C as a function of specimen size and position of specimen within the bars also are given. The volume-time relationships at 300 and 600°C can be expressed satisfactorily by $v = A \log t + B$ over extended intervals of time. A linear relationship prevails at 1000°C only after heating for longer than ~800 min. The volume and composition of the desorbates obtained at 1000, 1400, and 1800°C using induction heating are tabulated. (auth)

15537 (SRO-99) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT, FEBRUARY 1964. (Savannah River Operations Office, AEC). 13p.

Research and development efforts connected with the AEC/AECL cooperative program are reported in terms of: testing of on-power refueling machine for CANDU reactor, testing of CANDU prototype boiler sections, creep-rupture testing of SAP materials, ultrasonic testing of fuel sheathing materials, fluid dynamic and heat transfer studies, zirconium technology, irradiations programs, D_2O technology, and fuel development. Other R&D work discussed includes: studies for the thorium breeder reactor program, thorium fuel cycle studies, physics experiments for EL-4 reactor, design studies for Deuterium Moderated Demonstration Converter Reactor (DDCR), fuel element development, HWCTR driver fuel fabrication, and design status of a 300-Mw(e) D_2O moderated reactor. Operations data for the HWCTR and the CANDU assembly are summarized. Proposed fuel irradiations studies are listed. Development studies for the Carolinas-Virginia Tube Reactor are described. (B.O.G)

15538 (TID-20136) [POWER REACTOR DEVELOPMENT]. First Annual Report. (Società Elettronucleare Nazionale, Rome). 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 003-61-REP. 27p.

Progress is reported on the development of the Garigliano Power Reactor to 1963. Information is included on construction, characteristics, design modifications, economic aspects, procuring of equipment, specifications, training programs, testing of components and auxiliaries, operation, and problems occurring during the development of the plant. (N.W.R.)

15539 (TID-20142) GARIGLIANO NUCLEAR POWER PLANT COST ESTIMATE AND EXPENDITURES. Financial Report, June 30, 1963. (Società Elettronucleare Nazionale, Rome). 4p.

Cost estimates and expenditures are reported for the Garigliano Power Plant up to June 30, 1963. (N.W.R.)

15540 (TID-20284) NEUTRON SOURCE DESIGN. P. M. Wood (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Sept. 26, 1960. Contract [AT (11-1)-654]. 50p. (EGCR-STUDY-II-680)

Tentative dimensions and properties were established for the antimony-beryllium source of the Experimental Gas Cooled Reactor. Two source configurations were considered: a single source in a fuel channel near the center of the core or four small sources located between fuel channels near the center. Neutron yields, the initial activation required, gamma heat production, shielding required for shipment, and compatibility of the source with its environment were determined. The analytical methods used are outlined. The four-source arrangement will be used. (D.C.W.)

15541 (TID-20285) DUAL LOOP SIMULATION [OF THE] EXPERIMENTAL GAS COOLED REACTOR. P. J. Lain and R. A. Hedin (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Nov. 30, 1962. Contract [AT(11-1)-654]. 408p. (EGCR-STUDY-II-651)

The derivation and simulation by analog computer techniques of the behavior of the coolant system components of the EGCR are presented. The effects of a prescribed set of disturbances were evaluated to determine their effects on the operability of the plant were evaluated. These disturbances are: open loop, manually controlled maneuvers, loop resistance changes, steam demand change, scrams and loss of blower, helium relief valve operation, speed disturbances, and control system failures. The equations on which the analog computer model is based are given. Computer diagrams are presented and computer traces corresponding to the sets of disturbances are included. Steady-state data at various power levels are listed. Simulation of the plant control system indicated that the two reactor coolant blowers, operating in parallel, are inherently stable and that no unique settings of control gains in the automatic control system presented previously are effective for control over the entire range of automatic control. Slight modifications of the model gave automatic control over the power range from 20 to 100% without changing gain settings. (M.C.G.)

15542 (UNC-5062) PRESENT STATUS OF CALCULATION AND EXPERIMENT FOR D_2O-MODERATED NATURAL URANIUM LATTICES. W. L. Brooks, M. Raber, and G. Sofer (United Nuclear Corp. Development Div., White Plains, N. Y.). Sept. 13, 1963. 63p.

A survey of D_2O power reactors was performed, and a boiling D_2O-cooled concept was selected for early prototype construction. Absence of reliable reactivity data for large fuel clusters of interest in this reactor required the performance of confirming reactivity measurements. Void substitution type experiments (PLATR) permitted a large number of k_∞ reactivity measurements with minimum fuel inventory. Subsequent comparisons with full scale critical (PDP) measurements indicated agreement within the ±0.4% uncertainty in k_∞ measurements. The results of the reactivity measurements and reactivity methods indicate that sufficient reactivity is available in the recommended concept to achieve economic fuel life. (auth)

15543 (AEC-tr-6327) UTILIZATION OF PLUTONIUM IN THERMAL AND IN FAST REACTORS. J. Bussac, A. Kania, A. Meyer-Heine, G. Vendryes, and C. P. Zaleski. Translated for Oak Ridge National Lab., Tenn., from a paper presented at the "Expanded Colloquium of the European Society of Atomic Energy, Fuel Cycles for Power Reactors, Baden-Baden, September 9-14, 1963." 56p.

The problems connected with the production of plutonium in thermal reactors, the possibility of using plutonium in thermal reactors, and characteristics for the utilization of plutonium in fast reactors are discussed. Possible effects of plutonium utilization on the development of these types of reactors are also considered. (C.E.S.)

15544 (AEC-tr-6333) FUEL CYCLES IN GAS-COOLED, HEAVY-WATER POWER REACTORS. R. Naudet and M. Salesse. Translated for Oak Ridge National Lab., from a paper presented at the "Expanded Symposium of the European Society of Atomic Energy, Fuel Cycles in Power Reactors, Baden-Baden, September 9-14, 1963." 43p.

Financial, neutron-economic, and Pu-breeding aspects involved in the selection of fuel cycles for gas-cooled, heavy-water-moderated power reactors are reviewed. (T.F.H.)

15545 (AEC-tr-6337) OPTIMIZATION OF FUEL CYCLES IN A DYNAMIC PROGRAM OF INSTALLED POWER. J. Gaussens and L. Thiriet. Translated for Oak Ridge National Lab., Tenn., from a paper presented at the "Expanded Colloquium of the European Society of Atomic Energy, Fuel Cycles for Power Reactors, Baden-Baden, September 9-14, 1963." 28p.

An attempt is made to show the need to become familiar with the mechanism of the future Pu market in order to avoid errors concerning the prices to be set for it and the corresponding errors in the choice of the reactor characteristics. In order to define a market price of Pu, the insufficiency of the ideas of an equilibrium price with costs per kwh of reactors or of the substitution values for U-235 is reviewed. A market model is presented that permits consideration of the sensitivity of the results to the optimization parameters of reactors connected with the production or the consumption of Pu and that in particular demonstrates what can be called the program effect, which is the economic expression of technological and economic modifications in a certain reactor for the period of a program, related to the production or the consumption of Pu. It seems that the utilization of such models, while bringing no definitive solution, might usefully guide the technicians in economic considerations as required by the choice of characteristics for future reactors. (auth)

15546 THE POWER REACTORS. THE GRAPHITE–GAS COMBINATION. J. Horowitz and J. P. Roux. Atompraxis, 9: 472-5(Nov.-Dec. 1963). (In German)

The future prospects of graphite–gas reactors and recent development and new techniques are discussed. The developments and techniques considered are construction of reactor vessel with prestressed concrete, tubular fuel elements cooled inside and out, fuel cladding with Mg–Zr alloys, and incorporation of the blower and heat exchanger of the primary circuit within the reactor vessel. The utilization of some of these improvements has reduced the investment/kwe ratio by a factor of 3 between EDF-1 and EDF-3. (tr-auth)

15547 THE POWER REACTORS. FUEL ELEMENTS OF THE EDF REACTORS. R. Boussard and G. Jeanpierre. Atompraxis, 9: 476-80(Nov.-Dec. 1963). (In French)

The design, testing, fabrication, and performances of the fuel elements of the natural uranium–graphite–gas power reactors are reported. (J.S.R.)

15548 THE POWER REACTORS. A NEW HANDLING DEVICE. R. Martin. Atompraxis, 9: 480-3(Nov.-Dec. 1963). (In French)

The utilization of optimum burn-up for fuel elements, allowed by new metallurgical studies and fabrication procedures, necessitates a handling device for the fuel element during reactor operation. A new device that offers many advantages because of its lightness, simplicity, economy, accessibility, and automation is described. (J.S.R.)

15549 THE POWER REACTORS. THE HEAVY WATER–GAS COMBINATION. PLACE OF THE HEAVY WATER–GAS COMBINATION IN THE FRENCH PROGRAM. R. Naudet. Atompraxis, 9: 484-6(Nov.-Dec. 1963). (In French)

The heavy water–gas reactors offer numerous advantages over the light water reactors. They have a higher specific power and burn-up. These reactors have all the economic advantages of the natural uranium fuel cycles,

and they have vapor characteristics very close to those used in conventional power plants. (J.S.R.)

15550 THE POWER REACTORS. THE HEAVY WATER–GAS COMBINATION. THE EL-4 POWER PLANT. R. Carle and P. Schulhof. Atompraxis, 9: 486-92(Nov.-Dec. 1963). (In French)

The design and construction of the EL-4 power plant, moderated with heavy water and cooled with CO_2, are described. The core, primary cooling circuit, other cooling circuits, moderator processing, fuel handling, ventilation, production of electricity, and reactor control are the topics discussed. (J.S.R.)

15551 FAST BREEDER REACTORS. RAPSODIE, FAST NEUTRON EXPERIMENTAL REACTOR. R. Wustner. Atompraxis, 9: 493-505(Nov.-Dec. 1963). (In French)

After a brief review of the general characteristics of breeder reactors, the design and construction of Rapsodie are described. Possible future studies to be made with this reactor are indicated. (J.S.R.)

15552 FAST BREEDER REACTORS. LIQUID METALS AND FAST REACTORS. THE THERMAL INSTALLATIONS AT RAPSODIE. L. Vautrey. Atompraxis, 9: 506-12(Nov.-Dec. 1963). (In French)

Fast breeder reactors can be economic only if their production of fissionable material is significant. Cooling of these reactors offers difficult problems. Liquid metals, and particularly sodium, appear to be the best adapted for heat removal from these reactors. The studies undertaken in France on this aspect are reported, and the characteristics of the thermal installations of Rapsodie are defined. (tr-auth)

15553 FAST BREEDER REACTORS. FRENCH INDUSTRY AND THE DEVELOPMENT OF FAST REACTORS. C. Dambrine and M. Rozenholc. Atompraxis, 9: 512-15 (Nov.-Dec. 1963). (In French)

The Rapsodie project and the study of future fast reactors have created new disciplines in French industry. Reactors of this type have unusual requirements and call for little-known techniques, causing industry to deepen their knowledge and to perfect their fabrications and quality control. These problems are discussed in the article on the interrelationship of French industry and the development of fast reactors. (tr-auth)

15554 EXPERIENCE IN THE OPERATION OF THE YANKEE NUCLEAR POWER STATION. Ch. Held (Siemens-Schuckertwerke AG, Erlangen, Ger.). Atomwirtschaft, 9: 17-24(Jan. 1964). (In German)

The Yankee nuclear power station of the Yankee Atomic Electric Co. has an electrical capacity of 170 Mw. Several years operating experience is available. It was possible to increase the design capacity of 120 Mw(e), which was reached on Jan. 17, 1961, to 145 Mw(e) by the end of June 1961 and, after the introduction of the second core charge, this was further raised to 170 Mw(e) on Oct. 16, 1962. This extra capacity of 38% compared to the specification was attained essentially through the results of measurement by the comprehensive reactor core instrumentation. By extra zone loading with chemical shimming a further increase to a gross 190 Mw(e) is considered possible. The mean efficiency for 1962 was 28.96% with a self demand by the station of 7.19%. Excluding fuel element changes the plant availability was 95%. A load factor of 69% with a mean burnup of 8,350 Mwd/t of uranium was reached with the first core. On Feb. 28, 1963, inclusive of the time for changing fuel elements, a load factor of 65% with a total energy generation of 2×10^9 kwh was reached. A maximum burnup of 17 to 18,000 Mwd/t U might have been obtained in the first core. Experiments on the behavior with respect to disturbances and load changes showed that the installation worked perfectly when either automatically controlled or hand operated. Detailed opinions are given on the load shedding without fast disconnection, the loss of cooling medium flow at 120 Mw(e), and cooling by natural circulation as well as the automatic reactor control in the case of power operation. Observation of the behavior of the most important installation components resulted in the good working of the whole and maintenance required only a relatively small expenditure. The control rod drive shafts and the absorbing parts of the control rods with the zirconium extensions were replaced at the time of fuel change. The radiation levels in the various compartments of the reactor installation were in general very low. Generating costs already with the second core are about 20% below those expected. (auth)

15555 CIRCULATORS FOR HIGH-TEMPERATURE GAS-COOLED NUCLEAR REACTORS. R. Guck. Brown Boveri Rev., 50: 396-400(June-July 1963).

Of the nuclear power plants employing high-temperature gas-cooled reactors that are approaching completion, two are equipped with primary coolant circulators that were developed and manufactured by Brown Boveri. Although the requirements that these circulators have to fulfil are similar, two different technical approaches were made to the solution of the problems involved. The 'Dragon' reactor specified gas-lubricated bearings for the main coolant circuit. In contrast, the coolant circulator for the Brown Boveri-Krupp high-temperature reactor is an advanced design of blower with oil-lubricated bearings. Nevertheless, owing to the strictness of the requirements regarding gas-tightness, the technical problems in this respect had to be solved by completely new methods. After a brief introduction to the problems posed by high-temperature gas-cooled reactors on the circulators, a description is given of these two developments. (auth)

15556 THE CIRCULATORS FOR THE JÜLICH REACTOR. P. Ochs. Brown Boveri Rev., 50: 401-8(June-July 1963).

Attention is devoted to: design and operation of the circulators; bearings; purposes of the labyrinth seals; the oil supply; oil removal from the filtering gas; assembly of the circulators with the reactor; and supervision and control. (T.F.H.)

15557 THE MAIN CIRCULATORS FOR THE DRAGON REACTOR. J. Eggmann. Brown Boveri Rev., 50: 409-16 (June-July 1963).

Attention is given to: design of the circulators (casings, internals, impellers, shafts, bearings, jacking gas, and thermal problems); electrode seals; instrumentation; test rigs; and development of gas-lubricated bearings. (T.F.H.)

15558 D_2O REACTORS—A PRIORITY ON BIGNESS. Can. Chem. Process., 47: 60; 60-3(June 1963).

A review on the priority of D_2O reactors is given. Economies of scale should permit a considerable reduction in unit power costs for D_2O-cooled reactors. In view of the competitive economic position and advanced stage of design and development, the D_2O-cooled reactor deserves priority for extension to higher power ratings. However, the organic cooled and boiling (or fog) cooled variants offer sufficient economic attraction to justify continued development. The potential of these is such that at least another 10% could be lopped off the best costs obtainable from D_2O-

cooled reactors. Data are given on four reactor concepts in profile: D_2O cooled; boiling H_2O cooled; H_2O fog cooled; and organic cooled. (P.C.H.)

15559 CONTROL OF THE CHINON NUCLEAR POWER PLANTS. R. Fays and J. Pupponi. Energie Nucl., 5: 562-72(Dec. 1963). (In French)

The characteristics of nuclear power stations, especially those of the uranium-graphite-gas type, and their regulation and automation, are discussed. When information is being processed, a great many measures are added to those usually used by the classical thermal power stations. The description of the information processing operation of the control rooms for each of the three units; EDF-1, EDF-2, and EDF-3, brings out the evolution of the control design in the nuclear power stations. This causes an increase in the security of a better output and a decrease in the duration of the transient states. (auth)

15560 ENRICO FERMI SHIELD-PLUG RESPONSE TO A 1,000 LB TNT ACCIDENT. W. R. Wise, et al. Expti. Mech., 3: 245-52(Oct. 1963).

Access to the sodium cooled core of the 100 Mw fast breeder reactor is provided by a 143 ton shield plug. The maximum credible nuclear accident for the Fermi reactor has been postulated not to exceed in violence the detonation of 1000 lb of TNT at the core location. Scaled charges of TNT (cased in molten sodium) were detonated in idealized models of the Fermi reactor. The results of the experiments together with available theory indicate that the accident would be contained in the reactor shielding complex but that the 143 ton shield plug, if unimpeded, might be propelled through the roof of the containment building. In response to the findings of this extensive study, the Fermi reactor will be equipped with an arrester that will prevent a hazardous plug jump in the unlikely event of a nuclear accident. (TCO)

15561 NUCLEAR METALLURGY. VOLUME IX. A SYMPOSIUM ON MATERIALS FOR SODIUM-COOLED REACTORS 1963 WINTER MEETING OF THE AMERICAN NUCLEAR SOCIETY, NEW YORK. L. R. Kelman and Sherman Greenberg, eds. Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser., No. 12, 1-281(1963). New York, Metallurgical Society of American Institute of Mining, Metallurgical and Petroleum Engineers. $7.00.

Seven articles are included; each was abstracted separately in NSA. (P.C.H.)

For abstracts of individual papers see: 15562, 15563, 15564, 15565, 15566, 15567, and 15568.

15562 NUCLEAR CONSIDERATIONS IN THE SELECTION OF MATERIALS FOR FAST POWER REACTORS. David Okrent (Argonne National Lab., Ill.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser., No. 12, 1-56(1963).

The nuclear performance of large fast power reactors is reviewed, with particular emphasis on factors affecting the breeding ratio and the sodium void reactivity effect. Basic cross sections, important reactivity coefficients, and typical performance characteristics for large and very large reactors using conventional and hybrid fuel cycles are discussed. Also included are some comments on the nuclear characteristics of coolants other than sodium, some discussion of long-term reactivity and fuel recycle effects, some estimates of the uncertainty in theoretical predictions, and a brief review of some safety aspects of fuel element design. (P.C.H.)

15563 MATERIALS FOR ARGONNE NATIONAL LABORATORY SODIUM COOLED REACTORS. R. E. Macherey, W. R. Simmons, and R. A. Noland (Argonne National Lab., Ill.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser., No. 12, 57-114(1963).

The Argonne National Laboratory has built two alkali metal cooled unmoderated reactors and is now designing a third such reactor. The first of this series, EBR-I, a 1 Mwt sodium–potassium cooled device, is constructed of AISI Type 347 stainless steel except for a few components of nichrome, Inconel, and Type A nickel. A special heat of strongly austenitic Type 347 stainless steel was employed in the core region. At the reactor tank outlet, the NaK reaches 322°C. In over ten years of operation, no material-associated difficulties of significance have been encountered in EBR-I. EBR-II, rated at 60 Mwt and designed to operate at a sodium coolant outlet temperature of 500°C, is built, but has not yet operated. Based on the successful EBR-I experience with austenitic stainless steel, the major material of construction in EBR-II is Type 304 stainless steel. In addition, a 2-¼ wt % Cr–1.0 wt % Mo low alloy steel is used extensively in the steam and sodium sections of the secondary system. The steam generation system employs sodium-heated steam generators designed on the same basic principles as those successfully used in EBR-I. AISI Type 304L stainless steel is the cladding in the present uranium alloy core. Future cores will contain plutonium in the fuel alloy. Jacket materials new to sodium service in reactors are required to clad these alloys. Necessary properties of these materials are resistance to sodium corrosion, compatibility with the fuel, and good mechanical strength. The Fast Reactor Test Facility (FARET) is presently being designed to operate at 50 Mw with a 650°C maximum sodium coolant temperature. Because of the high operating temperature, choice of AISI Type 304 is not obvious for critical components such as the reactor vessel, system piping, and pump bodies. Materials being consider are Hastelloy-C, ARMCO 17-14 copper–moly, Uniloy N 155, Croloy 16-8-2, and Types 304 and 316 stainless steel. At present Types 304 and 316 stainless steel are the leading candidates. (P.C.H.)

15564 MATERIALS PROBLEMS AND SELECTIONS IN THE ENRICO FERMI FAST BREEDER REACTOR. E. C. Kovacic, W. E. McHugh, and A. A. Shoudy, Jr. (Atomic Power Development Associates, Inc., Detroit). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser., No. 12, 115-74(1963).

A review is presented of the principle materials used in the Enrico Fermi Fast Breeder Reactor. Materials covered include primarily those used within the reactor itself, such as the nuclear fuel, the support mechanisms, the safety and control rods, and the radiation shields. In areas where specific tests were run to verify the application of specific materials, the tests are described. Emphasis is also placed on some of the material problems that were encountered in the non-nuclear testing of the reactor system. Included is a discussion on the steam generator used for the EFFBR. (auth)

15565 SELECTION AND APPLICATION OF AN AUSTENITIC STAINLESS STEEL FOR THE FABRICATION OF THE PRESSURE VESSEL FOR THE FAST REACTOR RAPSODIE. A. Guegnaud and C. Roques (Euratom, Brussels and Commissariat a l'Energie Atomique, Paris). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser., No. 12, 175-206(1963).

The responsibility for the selection of a suitable stainless

steel for the design and fabrication of the pressure vessel of the French fast reactor RAPSODIE led to an investigation of the effect of several material, welding, and heat treating variables on the properties of welded joints. Investigated were niobium and titanium stabilized stainless steel, molybdenum containing stainless steels, and a stainless steel containing both molybdenum and boron. These materials were welded with coated electrodes or welding rods in a protective argon atmosphere and a variety of tests were made on the base materials themselves and on the welded test pieces. Creep rupture tests up to 16000 hours and at temperatures ranging from 550 to 650°C under loads of up to 60 Kg/mm^2 were carried out. The tests were supplemented with impact tests on notched and plain specimens, hardness measurements, metallographic examinations, and determinations of the reduction of area as a measure of high temperature ductility. The effect of a stress relief treatment at 1050°C and cooling to a predetermined lower temperature at the rate of 50°C/hr and subsequent cooling in air was studied. As a result of the tests molybdenum, tungsten, and manganese were considered to be favorable alloying elements of the base material while boron, titanium, and niobium were considered to be unfavorable. The hot ductility of the titanium and niobium stabilized stainless steels was particularly poor. Molybdenum additions gave satisfactory results and molybdenum plus boron additions gave excellent results. The selection of the electrodes and the welding rod materials was governed by the same considerations as that of the base materials. Creep rupture tests on actual welded joints frequently showed a marked decrease of creep rupture strength when compared with that of the base metal, sometimes by a factor of ten. However, experiments with the composition 17 Cr–13 Ni–2 Mo plus boron showed no such decrease. Rupture occurred always in the welds and with greater rupture ductility. Other molybdenum containing alloys also behaved in the same way. It was concluded that a satisfactory vessel can be fabricated by using an austenitic stainless steel with molybdenum additions and partially ferritic electrodes of the 18 Cr–11 Ni–2 Mo type having a rigorously controlled delta ferrite content. A full scale mock-up of the reactor vessel was built without any welding incidents. (P.C.H.)

15566 MATERIALS SELECTION CONSIDERATIONS FOR FCR AND SEFOR. R. W. Lockhart and G. Billuris (General Electric Co., San Jose, Calif.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser., No. 12, 207-25(1963).

Requirements for reactor plant materials that contact sodium are reviewed. Materials selection for the reference design of the Fast Ceramic Reactor is based largely upon available data and technology. Current experienced programs for fuel development, sodium mass transfer, and physical properties determination for materials in sodium are providing backup information in the evaluation of reference design and alternate materials. The most significant exposure effects derived from the initial 2000 samples from the Sodium Mass Transfer program include the composition changes of the surface of the type 316 stainless steel and the steep carbon gradient near the surface of samples when 2¼ Cr–1 Mo alloy steel is contained in the system. The degree and rate of carbon depletion of the ferritic steel is indicated. Observed corrosion data indicate that all of the materials tested could be considered for use in sodium cooled plants at temperatures up to 1200°F. (auth)

15567 STRUCTURAL MATERIALS IN LASL LIQUID SODIUM SYSTEMS. Howard I. Bowers and William E. Ferguson (Los Alamos Scientific Lab., N. Mex.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser., No. 12, 227-55(1963).

The design, fabrication, and post-operative tests and inspections of the 2000 kw Sodium Test Facility that was constructed and operated at the Los Alamos Scientific Laboratory are discussed. Of special interest are: post-operative inspection of heat exchanger tubing; the investigation of a rupture in a thermocouple well; and the investigation of the thermal stress fatigue cracking of a pipe tee and adjacent piping. Discussed briefly are operating experience with 17-4 PH stainless steel in the LAMPRE sodium system and the results of corrosion tests of tantalum in cold-trapped and hot-trapped sodium. (auth)

15568 MATERIALS FOR SODIUM GRAPHITE REACTORS. W. C. Hayes, W. J. Anderson, P. E. Elkins, and D. L. Johnson (Atomics International, Canoga Park, Calif.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser., No. 12, 257-81(1963).

The choice of materials for the Sodium Reactor Experiment (SRE), Hallam Nuclear Power Facility (HNPF), and Advanced Sodium Graphite Reactor (ASGR) are described, and specific technical areas that required consideration for these applications are discussed in detail. A chromatographic analysis of gases over liquid sodium was investigated as a means of monitoring the impurities carbon, oxygen, nitrogen, hydrogen, xenon, and krypton. In addition to the detection of impurities, an effort was made to relate the gas composition to the carburizing potential in the liquid sodium. (P.C.H.)

15569 STATUS OF GAS COOLED REACTOR PROGRAM. Ray M. Evans and Allan E. Goldman (Oak Ridge National Lab., Tenn.). Metal Progr. 85: 118-22(Mar. 1964).

Developments in the EGCR program are presented. Instrumented fuel assemblies, operation of a helium cooled loop, radiation damage and self-diffusion, and prestressed concrete pressure vessels are discussed. (P.C.H.)

15570 THE DEVELOPMENT WORK LEADING UP TO THE MARVIKEN NUCLEAR POWER STATION. P. H. Margen (Aktiebolaget Atominergi, Stockholm). Neue Tech., 5: 699-714(Dec. 1963).

After an enumeration of some economic factors in connection with the Marviken reactor and a short description of the plant, the main development problems such as heat transfer and hydrodynamics, dynamics, materials, fuel elements, engineering problems, leakage, and containment are discussed. Several facts concerning time schedule are described. A view of future reactor development in Sweden is given. (auth)

15571 ESTIMATED AND ACTUAL COSTS OF CONSTRUCTION AND MAINTENANCE OF NUCLEAR POWER PLANTS IN EUROPE. Acts of a Panel Organised by the Italian Nuclear Committee (CNEN) in Collaboration with the Italian Nuclear Forum (FIEN), Rome, June 21, 1963. Nucl. Law Econ., 5: No. 1, 1-147(Sept. 1963). (In Italian)

Technological factors influencing the cost of nuclear energy, nuclear fuel costs in Europe, and revenue obtainable from nuclear power plants are discussed. (R.E.U.)

15572 NUCLEAR SAFETY ECONOMICS. J. A. Lane. Nucl. Safety, 5: No. 2, 139-45(Winter 1963-64).

An analysis is made of costs associated only with the

possible accidental release of radioactive material from the primary system. The costs of this type include these of the emergency supply systems, containment systems, site, and extra transmission lines resulting from remote plant location. Possible cost reductions are discussed. It is concluded that, with the possible exception of standard containment, the costs attributable to nuclear safety are quite low in large plants and not amenable to cost reduction, and that such costs are not an insurmountable barrier to economic nuclear power. (D.L.C.)

15573 ACTION ON REACTOR PROJECTS UNDERGOING REGULATORY REVIEW. J. R. Buchanan. Nucl. Safety, 5: No. 2, 207-15(Winter 1963-64).

The license-application record of various power reactors is tabulated. Recent regulatory actions and items of current interest relative to specific power reactors are described. (D.L.C.)

15574 TOWARD LONGER-LIFE ARMY-REACTOR CORES. J. G. Gallagher (Alco Products, Inc., Schenectady, N. Y.). Nucleonics, 22: No. 3, 62; 64; 66-8(Mar. 1964).

Various ways of lengthening the lives of the plate-type cores of the pressurized-water reactors SM-1, PM-2A, SM-1A, SM-2, and PL-3 are discussed. Longer core life was obtained by increasing plate thickness and weight fraction of fuel in the matrix and by incorporating a boron compound in the matrix to meet control requirements. (R.E.U.)

15575 NUCLEAR REACTOR POWER SOURCES. C. K. Smith (Atomics International, Canoga Park, Calif.). p.68-70 of "Proceedings, 16th Annual Power Sources Conference, 22-24 May 1962." Red Bank, N. J., PSC Publications Committee, 1962.

Descriptions and operational availabilities are presented for SNAP-10A, -2, and -8. (R.E.U.)

15576 THE BABCOCK AND WILCOX STEAM COOLED BREEDER REACTOR. Donald C. Schluderberg (Babcock and Wilcox Co., Lynchburg, Va.). 15p. (CONF-102-35).

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

Design objectives of the Babcock & Wilcox Steam Cooled Breeder Reactor are given, along with economics and important characteristics and an outline of the presently expected development program. (P.C.H.)

15577 HEAVY WATER IN HEAVY-WATER BASED NUCLEAR POWER PROGRAMMES. R. Ortiz Fornaguera (Junta de Energía Nuclear, Madrid). 49p. (CONF-410-1)

From EAES Enlarged Symposium on Heterogeneous Heavy Water Power Reactors, Majorca, Spain, Oct. 1960.

Various aspects associated with the use of heavy water in reactors are discussed including inherent properties and costs. Reactor programs in Europe and America are discussed. 97 references. (R.E.U.)

15578 TRANSIENT AND STEADY STATE PERFORMANCE OF THE INDIAN POINT REACTOR PLANT. S. H. Esleeck (Babcock and Wilcox Co., Lynchburg, Va.). 18p. (CONF-187-88; BAW-219)

From American Nuclear Society Meeting, New York, Nov. 1963.

The steady-state and transient performance of the plant exceed design requirements. The increase in hydraulic and thermal performance in the reactor coolant loops has opened up the possibilities of either increased reactor power and full power generation using possibly three loops and six pumps. Plant automatic control has thoroughly demonstrated precise steady state control with excellent plant response for rapid power changes. In the power range of 40 to 100% full power, an extrapolation of the transient test results indicate that the plant and controller response characteristics would allow 75-Mw(e) steps (27% power steps) and ramp rates as high as 42 Mw(e)/min (15-%/min). (auth)

15579 INDIAN POINT REACTOR REACTIVITY AND FLUX DISTRIBUTION MEASUREMENTS. M. L. Batch (Babcock and Wilcox Co., Lynchburg, Va.) and Frank E. Fischer. 9p. (CONF-187-80)

From American Nuclear Society Meeting, New York, Nov. 1963.

The reactivity of the Indian Point core was measured near zero reactivity at various shim and control rod patterns. Flux distribution measurements were also made, and the results are expressed in terms of power peaking factors and normalized detector response during rod withdrawal. (D.L.C.)

15580 A COMPARISON OF (PuU)C AND $(PuU)O_2$ FUELED FAST BREEDER REACTORS. A. Halim Kazi and Staneley Rosev. 25p. (CONF-187-81)

From American Nuclear Society Meeting, New York, Nov. 1963.

A conceptual evaluation is presented of a (PuU)C 500-Mw(e) reactor which uses a moderate power generation of 40 kw/ft and a maximum fuel temperature of 2900°F, well below the 4500°F melting point of $Pu_{0.2}U_{0.8}C$. The principal design characteristics and fuel cycle costs are tabulated together with those of a $(PuU)O_2$ design of equal power. The comparison shows that the carbide core has significant economic and safety advantages over the oxide core. (D.L.C.)

15581 CLUMPED LIGHT WATER MODERATED UO_2 SUPERHEAT CRITICALS. PART II. ANALYSIS. G. T. Petersen (General Electric Co., San Jose, Calif.). 14p. (CONF-187-70)

From American Nuclear Society Meeting, New York, Nov. 1963.

Critical and subcritical reactivity measurements on an EVESR-type core, using EVESR UO_2 superheat fuel elements, are analyzed in order to obtain a physics design model for use in the EVESR. (T.F.H.)

15582 CLUMPED LIGHT WATER MODERATED UO_2 SUPERHEAT CRITICALS. PART I. EXPERIMENTS. F. G. Warzek and H. F. Johnston (General Electric Co., San Jose, Calif.). 15p. (CONF-187-69)

From American Nuclear Society Meeting, New York, Nov. 1963.

The following critical and subcritical measurements were made in the EVESR core: reactivity with no control rods; full core reactivity with control rods; and power distribution in the full core with control rods. The fuel was UO_2, and the elements were of the superheating type. The reactor was light-water-cooled and -moderated. (T.F.H.)

15583 NOISE RESULTS ON YANKEE, SAVANNAH, AND CON ED REACTORS. Russell M. Ball and Melvin L. Batch (Babcock and Wilcox Co., Lynchburg, Va.). 25p. (CONF-332-13)

From Symposium on Noise Analysis in Nuclear Systems, Gainesville, Fla., Nov. 1963.

Sources, instrumentation for measurement, and measured values of the noise spectra in the Yankee Power Reactor, Indian Point Power Reactor, and N.S. Savannah Power Plant are described. Similarities between these reactors are noted. (T.F.H.)

Process Heat Reactors

15584 (TID-20319) PROCESS HEAT REACTOR PROGRAM. Quarterly Progress Report, August 1–October 31, 1963. (Bureau of Mines. Morgantown Coal Research Center, W. Va.). 21p.

A fluidized-bed gasifier was designed for the helium recycle induction-heated simulated nuclear reactor. Design and development of an environmental test apparatus in which alloys will be exposed to conditions comparable to those expected in a fluidized-bed gasifier are reported. Graphite-in-nitrogen suspensions containing 5 wt % bentonite were recirculated to determine the effect of bentonite on graphite deposition. A testing loop for the graphite-in-helium suspensions was designed. A device was developed for measuring the mass flow of solids in a suspension. (N.W.R.)

15585 NUCLEAR PROCESS HEATERS LOOK HOPEFUL. Can. Chem. Process., 47: 39-40; 42(May 1963).

The economics of nuclear fuel as compared with electricity and coal are discussed. Fueling costs of 7c/million Btu have been demonstrated for nuclear reactors, compared to 30-40c/million Btu that most plants must pay for coal, oil, or natural gas. However, it isn't possible to get 7-cent steam in small units because of design considerations. The desalinization of water, paper mill process heat, light-water vs organic, and high-temperature heat are discussed. (P.C.H.)

15586 LOW-TEMPERATURE HEAT-PRODUCING REACTORS. P. Wenzel (VEB Atomkraftwerk, Berlin). Kernenergie, 7: 1-8(Jan. 1964). (In German)

The different types of heat-producing reactors are reviewed. Advantages and disadvantages in the operation of reactors for the production of heat at low temperatures are discussed. Users of heat from reactors are surveyed, including the chemical industry, the paper and cellulose industry, tile works and the ceramic industry, the food industry including wholesale bakeries and grain processers, the textile industry and dye works, and water desalinization systems. New projects are listed. (M.C.G.)

Production Reactors

15587 (HW-79695) PERFORMANCE CRITERIA FOR IRRADIATION PROCESSING DEPARTMENT PRODUCTION REACTORS. F. W. Van Wormer, comp. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 20, 1963. Contract AT(45-1)-1350. 9p.

Criteria developed and adopted at Hanford for maintaining adequate cooling of fuel elements at all times by requirements placed on the coolant supply system and by control of the heat generation rates of each production reactor through control of the nuclear reaction are presented. Criteria for reactor coolant supply, nuclear control, and electrical transmission-distribution are included. (auth)

15588 (TID-7677(p.259-72)) HANFORD EXPERIENCE WITH REACTOR CONFINEMENT. J. W. Green, W. V. Thompson, and H. Copeland (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The confinement system of a Hanford reactor and tests on it are described. The ventilation system, filter facility, instrumentation, and fog spray are discussed. (M.C.G.)

15589 (TID-20206) HELIUM AND ULTRASONIC LEAK TEST ON N-REACTOR STEAM GENERATOR 4A. Physical Testing Memorandum Report PT-63-8. H. E. May (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 19, 1963. Contract [AT (45-1)-1350]. 7p.

The ultrasonic leak detector indicated possible leaks in 37 tubes in the N-Reactor steam generator 4A. However, interpretation of the information was difficult due to high background noise. A Veeco-9A helium leak detector was next used, and leaks in 8 of the 37 suspect tubes were confirmed. The helium leak detector and its operation are described. A correlation of the ultrasonic and helium leak test data is given. (D.L.C.)

Propulsion and Space

Refer also to abstract 14425.

15590 (NAA-SR-7938) A REACTOR TRANSIENT HEAT TRANSFER MODEL. D. G. Mason and R. W. Winson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 1, 1964. Contract AT(11-1)-Gen-8. 19p.

A transient heat transfer model of a SNAP-8 reactor core was developed which can be programed on a general purpose electronic analog computer using minimum equipment, but maintaining a high degree of accuracy. In addition, the model eliminates any erroneous response due to step changes in inlet coolant temperature. The transient responses of two models, both formulated from the physical system using the laws of conservation of mass and energy, were compared for step changes in power and inlet coolant temperature. One of the models was selected as having the desired transient accuracy in response to the input disturbances. (auth)

15591 (NAA-SR-Memo-9105) WATER IMPACT WAKE GENERATION STUDY. L. M. Polentz (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 9, 1963. Contract [AT(11-1)-Gen-8]. 40p.

The wake produced by a Snap 10A reactor striking the water with its axis perpendicular to surface of the water was investigated. Based on tests performed on a similarly shaped missile, it is estimated that the cavity created by the nine-inch diameter, 175 pound reactor would exceed 22.9 in. in diameter and be greater than 17.9 ft in length before it collapsed; the reactor would be deeper than 17.9 ft and the cavity would extend to the surface. The duration of the cavity would exceed 233 msec. It is probable that the size and duration of the cavity resulting from the impact of the 16-inch diameter reactor would also exceed these dimensions. (auth)

15592 (NAA-SR-Memo-9405) SNAP 2/10A HYDRAULIC STUDIES. K. A. Thomasson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 15, 1964. Contract [AT(11-1)-Gen-8]. 30p.

A partial model of the reactor core was used, and demineralized water was circulated at flow rates determined by the Reynolds analogy to the prototype. Black plastic beads were introduced into the flow stream and photographed by using a Milliken camera recording at 500 frames per second. Calculations showed that 79% of the total mass flow was accounted for by this method. The 21% of the mass flow that was not accounted for was presumed to be due to flow in non-channel areas and in two non-orificed channels. Some error could also be attributed to the use of non-spherical beads that created non-uniform

velocities in the channels. The visibility through the SNAP 2/10A core section, for the purpose of visual observation and optical recording, was very good. The high speed pictures were clear and sharp. The velocity determination based on the frame by frame analysis of the film did not present any problem. The experiment demonstrated that clear Lucite can be used as the material for visual flow observation in a full-scale SNAP 2/10A model core vessel. (auth)

15593 (NARF-58-28R) POROUS PLUG EXPERIMENT III. D. E. Evans and D. M. Wheeler (Convair, Fort Worth, Tex.). June 30, 1958. For General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati. Contract AF33 (600)-32054. 59p. (MR-N-212)

With the Ground Test Reactor as the source of radiation, measurements were made in the Outside Tank Facility of the dose rates behind two porous plugs and one slab plug used as a standard. Presented are the results of these measurements and a description of the Outside Tank Facility. Fast neutron results indicate a shielding weakness in the interior of the two porous plugs (but not the slab plug) such that the fast neutrons are effectively focused at some distance from the plug surface. These weaknesses cause a significant increase in the fast neutron dose rate at angles off the centerline and at distances of 20 to 100 ft from the reactor core center. Where possible, relative comparisons are made between measurements taken with these plugs in pool and in the Outside Tank Facility. Definite conclusions cannot be reached about the shielding effectiveness of these plugs until a further analysis of the internal construction of the plugs is completed. (auth)

15594 (NARF-58-29R) MULTILAYER SHIELD EXPERIMENT II. G. A. Luce, B. S. Burton, and D. M. Wheeler (Convair, Fort Worth, Tex.). June 30, 1958. Contract AF33(600)-32054. 75p. (MR-N-213)

The first tests of multilayer shield mock-ups in the Outside Tank Facility have been completed. The tests were designed to provide information for design of the shield for the XMA-1 power plant. In the experiment, slabs of various shielding materials were assembled in different arrangements into shield-sector mock-ups. These assemblies were then placed in the Outside Tank Facility and subjected to radiation from the Ground Test Reactor. Three types of measurements were taken: 1.) external measurements, with dosimeters and BF_3 counters; 2.) internal measurements, with activation foils and chemical dosimeters placed between shield layers; and 3.) external measurements of the gamma spectra emitted. Results of the internal measurements indicate that Hevimet is quite opaque to thermal neutrons, and that gamma rays from thermal and resonance neutron capture in Hevimet may contribute significantly to the external gamma dose rate. Hevimet capture gamma rays were found, in some cases, to cause a significant number of photoneutrons in mock-ups containing beryllium as well as those containing beryllium oxide. The effect of hydrogenous backing of non-hydrogenous neutron-shielding materials was found to be relatively small. For fast neutrons and gamma rays, the external dose rates were found to be independent of the location of the hydrogenous material within the non-hydrogenous column. The external thermal neutron flux was reduced most when the non-hydrogenous material was placed at the outer end of the mock-up. Many of the dose measurements indicate that gamma rays from capture in the OTF structural materials contribute significantly to the external dose. This conclusion is substantiated by the observed gamma-ray spectra. Typical gamma spectra are shown. (auth)

15595 (NARF-58-40R) MULTILAYER SHIELD EXPERIMENT IV, OTF III. R. L. Henry (Convair, Fort Worth, Tex.). Oct. 9, 1958. For General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati. Contracts AF33(038)-21102 and AF33(600)-32054, Subcontract AF-74. 51p. (MR-N-222)

A series of shield tests were conducted at the Nuclear Aircraft Research Facility at Convair-Fort Worth to obtain shield design information for nuclear aircraft reactors. This document contains the experimental results of one of these tests. In the experiment, slabs of various shielding materials were assembled in different arrangements into shield mock-ups. These assemblies were then placed in the Outside Tank Facility and subjected to radiation from the Ground Test Reactor. External measurements were taken with dosimeters and BF_3 counters; and internal measurements, with foils and chemical dosimeters. Results indicate that zirconium hydride is a good attenuator of gamma rays and fast and thermal neutrons, that the relaxation lengths for zirconium hydride in a BeO matrix are the same for fast neutrons and gammas, that fast neutrons and gamma rays are attenuated exponentially in zirconium hydride, and that there is relatively little production of secondary gamma radiation in zirconium hydride due to thermal neutron capture and inelastic scattering of fast neutrons. Lead, especially in large thicknesses, seems to produce a relatively high secondary gamma dose rate. Although thermal neutron shielding, when placed forward of uranium in a shield mock-up, does lower the gamma dose rate, the reduction is not great. (auth)

15596 (NYO-8590) UPGRADING OF N.S. SAVANNAH INSTRUMENTATION AND CONTROL SYSTEM. Phase I, Final Report, April–June 1961. D. Gertz and W. Keating (Ford Instrument Co., Long Island City, N. Y.). July 21, 1961. Contract AT(30-1)-2764. 124p.

Results are reported of the Phase I study. Included is a discussion of the detailed review of the power plant control system and recommendations for the elimination and replacement of components which will result in a more reliable operating system. Basic control techniques are discussed and conclusions drawn as to the potential improvements in system performance which can be attained by altering the control logic. Recent technological advances in instrumentation engineering provided the basis for an investigation of these techniques which may ultimately lead to achieving economic nuclear power for merchant ships. Thus, a preliminary study of advanced instrumentation approaches was carried out and developments recommended which appear to offer the maximum reliability, safety, and simplicity in an all-electric control system. (auth)

15597 (TID-7677(p.545-52)) PRELIMINARY DESIGN CONSIDERATIONS — EFFLUENT CLEANING SYSTEM FOR THE 630 A GAS-COOLED MARITIME REACTOR. J. E. Maxwell (General Electric Co. Nuclear Materials and Propulsion Operation, Idaho Falls, Idaho).

A system for treatment of radioactively contaminated air from an air-cooled nuclear steam generator for maritime service before its release to the atmosphere is being developed. It is planned that any air passing to the atmosphere from the primary coolant loop will flow through charcoal adsorption beds. (M.C.G.)

15598 (TID-20079) SYSTEMS FOR NUCLEAR AUXILIARY POWER. AN EVALUATION, JANUARY 1964. (Division of Reactor Development, AEC). 37p.

The requirements and potential applications for radioisotope and reactor SNAP systems are summarized. A technical review of the SNAP reactor programs, including the associated lithium cooled reactor experiment, is presented; and alternate approaches are evaluated. Radiation and safety considerations of isotopic SNAP systems are discussed, together with the economics of such systems and isotope availability. Characteristics and uses of SNAP systems are also tabulated. (D.C.W.)

15599 (TID-20103) SYSTEMS FOR NUCLEAR AUXILIARY POWER. A REPORT BY THE COMMISSION, 1964. (Atomic Energy Commission, Washington, D. C.). 23p.

The uses and possible systems for auxiliary power, particularly for space applications, are indicated; and the extent to which nuclear systems meet the requirements is discussed. The current and planned development programs are outlined, and the AEC's conclusions on the overall SNAP program are presented. The status, characteristics, and uses of various SNAP generators are tabulated. (D.C.W.)

15600 N. S. SAVANNAH SAFETY ASSESSMENT. H. C. McCurdy. Nucl. Safety, 5: No. 2, 146-9(Winter 1963-64).

The operation of NS Savannah under interim criteria in 1962 and 1963 is surveyed briefly. Operating experience and interim criteria were reviewed by regulatory groups, and the group reports are reviewed with respect to engineered safeguards, mobility, and operating personnel. The reservations held by the regulatory groups in the substitution of safeguards and mobility for distance in stationary reactor safety criteria are discussed. (D.L.C.)

15601 THE FUTURE OF THE RANKINE CYCLE IN SPACE. Harold L. Davis. Nucleonics, 22: No. 3, 34-6 (Mar. 1964).

The future use of SNAP Rankine cycles having liquid-metal-vapor turbines and liquid-metal pumps is discussed. MHD concepts and SNAP-50 technology are reviewed. (R.E.U.)

15602 LIQUID METALS AS WORKING FLUIDS FOR POWER-GENERATION SYSTEMS TO BE USED IN SPACE. Edmond E. Bisson. p.451-68 of "Advanced Bearing Technology." Washington, D. C., National Aeronautics and Space Administration, 1964.

The variables and requirements involved in various missions are reviewed. Turbogenerator systems for low and high power levels are described. The physical properties and corrosion aspects of liquid metals which may be used as working fluids are discussed. (D.L.C.)

Research and Test Reactors

15603 (BNL-6730) HIGH BURN-UP TESTS OF U–Al FUEL ELEMENTS. J. R. Weeks, S. B. McRickard, and D. H. Gurinsky (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT(30-2)-Gen-16. 7p.

A series of irradiation tests were performed on the High Flux Beam Reactor fuel elements. The U–Al fuel elements contained 30 to 40 wt % U and 3% Si. Burnup ranged from 20 to 50%. A summary of the results is given. (C.E.S.)

15604 (CRDC-1177) FISSION-PRODUCT RELEASE FROM THE NRX 1952 ACCIDENT. W. J. Edwards (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1963. 12p. (AECL-1877)

The nature of the fallout observed downwind of the reactor stack following the 1952 accident was considered in terms of recent data on the fission-product emission from oxidizing uranium. The data, assembled from various authors, are interpreted as suggesting that the activity observed locally would be similar to that associated with briefly irradiated uranium and that no particular enhancement in more volatile fission products would be expected. (auth)

15605 (DP-885) HEAVY WATER MODERATED POWER REACTORS. Progress Report, November–December 1963. R. R. Hood, comp. (Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.). Jan. 1964. Contract AT(07-2)-1. 40p.

The HWCTR was shut down during early Nov. for cleanup of the liquid D_2O loop after a fuel failure occurred during an irradiation test. During the second shutdown that began later in the month, all of the driver assemblies were replaced, new control rods were charged, and miscellaneous repairs were effected. Further postirradiation examinations of Zircaloy-clad UO_2 tubes confirmed earlier indications that columnar grain growth began at a thermal rating ($\int kd\theta$) of 25 to 35 watts/cm. As the first step in developing a tubular fuel element of Th that would be suitable for use in a D_2O–Th breeder reactor, an HWCTR irradiation test of two Th metal tubes has been designed. Tentative design data were formulated for use in a design study of a D_2O-cooled-and-moderated prototype reactor that is capable of operation on either the U^{238}–Pu cycle or the Th–U^{233} cycle. (auth)

15606 (EURAEC-889) PLUTONIUM RECYCLING. Quarterly Report No. 12. (France. Commissariat a l'Energie Atomique, Paris). 1963. Work Performed under United States–Euratom Joint Research and Development Program. 15p.

The fabrication and properties of plutonium–uranium and molybdenum–uranium fuel elements are discussed. The research activities on Aquilon, Minerve, and Marius reactors are summarized along with the irradiations of fuel materials in EL-3 reactor. (N.W.R.)

15607 (GA-3075) USES FOR THE PULSED TRIGA REACTOR. Prepared During a Visit at John J. Hopkins Laboratory. H. Maier-Leibnitz (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Apr. 5, 1962. 7p.

Possible uses of a pulsed reactor in work on fast decay (fission chains after partial mass separation) or on double processes (double neutron capture) are discussed; and a proposed time-of-flight facility for subthermal neutrons is described, together with some of its possible uses. The facility could yield about 10^8 neutrons above 4 Å per pulse, with a resolution of 15%. A neutron guide using total reflection inside a tube to contain the neutron beam is part of the facility. (auth)

15608 (HW-SA-3321) THE PLUTONIUM RECYCLE PROGRAM AT HANFORD. N. G. Wittenbrock (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 16, 1964. Contract AT(45-1)-1350. 44p.

The background leading to the Plutonium Recycle Program and its purpose are reviewed briefly. A brief description is given of each of the program facilities: Plutonium Recycle Test Reactor, Plutonium Recycle Critical Facility, Plutonium Fabrication Pilot Plant, and Fuel Recycle Pilot Plant. Highlights of some of the accomplishments of the program are given, and contributions to reactor and fuel technology are pointed out. (D.L.C.)

15609 (IDO-16896) ARMF II REGULATING ROD READOUT AND SHIM ROD DRIVE AND POSITION DISPLAY. R. I. Little (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Sept. 25, 1963. Contract AT(10-1)-205. 35p.

A description of the digital readout and drive portion of the Advanced Reactivity Measurement Facility II is presented along with the philosophy used in selecting the system block diagram and components, accuracy considerations, and a preliminary evaluation of performance and usability. The presentation discourages duplicating of the equipment; advantage should be taken of the opportunity to improve upon it. To this end guideposts are provided as well as a documentation of those aspects of the design that are considered worthy of duplication. (auth)

15610 (LFEN-1) RPI—THE PORTUGUESE ONE MEGAWATT SWIMMING POOL RESEARCH REACTOR. Reactor Project and Preliminary Hazards Report. Carlos Cacho (Portugal. Junta de Energia Nuclear. Laboratório de Física e Engenharia Nucleares, Sacavem). 1963. 130p.

Preliminary plans are presented for a Portuguese nuclear center, to be centered around a 1-Mw swimming-pool reactor with irradiation facilities. The hazards analysis includes reactor operation, waste disposal, meteorological data, and geological analysis of site. (D.L.C.)

15611 (TID-7677(p.248-58)) THE APPLICATION OF IODINE ABSORBER UNITS TO THE HWCTR CONTAINMENT SYSTEM. L. M. Arnett and G. C. Rusche (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.).

An analysis was made of the extent to which the installation of iodine absorber units in the containment building of the Heavy Water Components Test Reactor (HWCTR) can be expected to reduce radiation exposures of personnel in the vicinity of the facility during a release of fission products from the reactor core. Because the radioiodines contribute substantially to the whole-body dose and constitute almost entirely the thyroid dose, any mechanism that eliminates these isotopes from the materials escaping from the building reduces considerably the radiation hazard outside the building. This evaluation of the maximum credible accident revealed that the operation of efficient iodine absorbers reduces the radiation hazards to commonly acceptable levels even though the leak rates from the containment building are relatively high. At leak rates in the vicinity of 2% of the building contents per day, the whole-body dose and the thyroid dose received by personnel at the Plant boundary three miles from the HWCTR would be less than 25 r and 30 rem, respectively, in 30 days. The effect of the iodine absorbers was to reduce the expected whole-body dose by a factor of two and the expected thyroid dose by a factor of one hundred. (auth)

15612 (UCRL-7611) THE LPTR SINGLE-CRYSTAL NEUTRON SPECTROMETER AND REACTOR SPECTRUM MEASUREMENTS. Ian R. Jones (California. Univ., Livermore. Lawrence Radiation Lab.). Dec. 1, 1963. Contract W-7405-eng-48. 58p.

A spectrometer suitable for reactor spectrum measurements, neutron diffraction work, and certain neutron cross-section measurements is described. Its unique design features include neutron collimators coated with an organic compound that eliminates total reflection of neutrons from their surfaces and a crystal orienter designed to circumvent the problem of parasitic reflections. Design considerations such as instrument resolution, collimator design, shielding, and component precision are discussed. The calibration and alignment of the spectrometer and its individual components are described. The problems of measuring reactor spectra with a single-crystal neutron spectrometer are considered individually. The equations commonly employed in the calculation of crystal reflectivity are shown to be deficient, and appropriately modified equations are presented. A reactor spectrum measurement was made with the instrument, and the modified equations were used to analyze the data. The spectrum was measured from 0.5 to 4.0 Å (0.327 to 0.0051 ev) using the (111) planes of a lead single crystal. The effective neutron temperature was found to be 361 ± 7°K, which is 51 ± 7°K above the average moderator temperature of 310°K. The experimental results are compared with a theoretical Maxwellian distribution, and the differences are discussed. 55 references. (auth)

15613 FRENCH RESEARCH REACTORS. THE EL-3 REACTOR. C. Candiotti. Atompraxis, 9: 442-6(Nov.-Dec. 1963). (In French)

The principal characteristics of the EL-3 Reactor are tabulated, and its irradiation facilities and its experimental uses are described. The incidents in the operation of the reactor and its experimental apparatus are cited. Proposed modifications to the lattice and the system for cladding rupture are reported. (J.S.R.)

15614 FRENCH RESEARCH REACTORS. LIGHT WATER REACTORS. MELUSINE AND TRITON. R. Beauge, M. Jacquemain, and P. Millies. Atompraxis, 9: 447-50 (Nov.-Dec. 1963). (In French)

The characteristics of the swimming pool reactors Melusine and Triton are reported. The use of Triton for the study of reactor shielding is discussed. The experimental facilities and the improvements made in the reactors since construction are described. (J.S.R.)

15615 FRENCH RESEARCH REACTORS. LIGHT WATER REACTORS. SILOÉ. G. Denielou and P. Milliés. Atompraxis, 9: 450-4(Nov.-Dec. 1963). (In French)

The characteristics of Siloé are tabulated, and the solutions to the problems posed by the flux increase are reported. Although Siloé is a classical swimming pool reactor, it has original features in its control system and use of flywheels on the primary pumps. These are discussed. Siloette, a small reactor for routine measurements on a core identical to that of Siloé but with low power (less than 100 kw), is briefly described. (J.S.R.)

15616 FRENCH RESEARCH REACTORS. LIGHT WATER REACTORS. OSIRIS. B. Lerouge and J. Bernot. Atompraxis, 9: 455-6(Nov.-Dec. 1963). (In French)

The Osiris was designed as a materials testing reactor, cooled and moderated with light water, with a nominal thermal power of 50 Mw. The design characteristics of this reactor, whose construction was to start in October 1963, are reported. (J.S.R.)

15617 FRENCH RESEARCH REACTORS. LIGHT WATER REACTORS. PÉGASE. A. Deville. Atompraxis, 9: 457-61(Nov.-Dec. 1963). (In French)

The Pégase is a high-flux reactor designed for the systematic testing of the radiation behavior of fuel elements of gas-cooled power reactors. The design, construction, and utilization of this reactor are described. (J.S.R.)

15618 FRENCH RESEARCH REACTORS. UTILIZATION OF THE RESEARCH REACTORS FOR CEA PROGRAMS. P. Delattre. Atompraxis, 9: 461-7(Nov.-Dec. 1963). (In French)

The needs connected to the general program of the CEA

and the utilization of the existing reactors to satisfy these needs are reported. The fuel elements, graphite behavior, and compatibility between CO_2 and graphite are studied for the graphite–gas combination reactors. For the heavy water–gas reactors, the research programs include the fuel and the cladding or structural materials. Behavior of various fuels and the cooling circuits are of interest in the fast neutron reactors. The specific use to which each of the research reactors is put is briefly discussed. (J.S.R.)

15619 FRENCH RESEARCH REACTORS. DEVELOPMENT OF TECHNIQUES FOR THE RADIOLOGICAL EXAMINATION OF FUEL ELEMENTS FOR THE EL-3 REACTOR. P. Blum. Atompraxis, 9: 467-71(Nov.-Dec. 1963). (In French)

The problems posed by the examination of the fuel elements irradiated in the EL-3 Reactor are explained. The devices for the radiological examination, both old and recent, are reviewed. The device currently in use is a combination radioscope and moving radiograph. (J.S.R.)

15620 MAIN PROBLEMS ARISING FROM THE BUILDING OF SILOÉ. J. Chatoux. Bull. Inform. Sci. Tech. (Paris), No. 78, 15-21(Dec. 1963). (In French)

Administrative and technical problems which arose during construction of Siloé are discussed. Structures, methods and main technical problems which had to be overcome are emphasized. (auth)

15621 CONTROL SYSTEM OF SILOÉ. V. Delcroix, G. Deniélou, M. Guérin, and J. Delpuech. Bull. Inform. Sci. Tech. (Paris), No. 78: 23-38(Dec. 1963). (In French)

The conception of Siloé control system is founded on a number of principles: philosophy of the reactor operation; nature, treatment, and action of information; control-rod drive and automatic control; and connection between pile and experiments. Extreme care in execution is emphasized. Details about equipment for nuclear, thermodynamic, health measurements are included in appendices. (auth)

15622 THE CORE [OF SILOÉ]. C. Meunier and P. Ageron. Bull. Inform. Sci. Tech. (Paris), No. 78, 39-46(Dec. 1963). (In French)

After a short description of the Siloé reactor core, detailed characteristics of grid, fuel assemblies, reflector elements, control rods, water boxes, and plugs are given. Two first core configurations are described including preliminary results of operating experience. (auth)

15623 HYDRAULIC AND THERMAL STUDIES [OF SILOÉ]. P. Ageron, S. Fabrega, and J. Skok. Bull. Inform. Sci. Tech. (Paris), No. 78, 47-58(Dec. 1963). (In French)

The principle of the Siloé reactor cooling system is one of a classical swimming-pool pile. After passage downward through the core demineralized water enters a deactivation tank, then heat exchangers (water-water) and then returns to the swimming pool. The primary and secondary cooling systems, hydraulic characteristics of core components, thermal studies of hot-channels (maximum fuel-plate surface temperature, flow distribution, hot spot factors), and hydraulic and thermal simulation of transient operating conditions are described. (auth)

15624 ENGINEERING [OF SILOÉ]. P. Ballenzi. Bull. Inform. Sci. Tech. (Paris), No. 78, 59-67(Dec. 1963). (In French)

The Siloé reactor building and the annexes are described. Details are given about the containment shell, the office wing, the equipment building, the ring gallery, the jumping shell, the control station of liquid effluents, and the exhaust stack. (auth)

15625 EXPERIMENTAL FACILITIES AND HOT CELLS [FOR SILOÉ]. C. Coste de Bagneaux, G. Deniélou, and G. Mitault. Bull. Inform. Sci. Tech. (Paris), No. 78, 69-83(Dec. 1963). (In French)

Experimental facilities and hot cells for Siloé are described. Utilities, handling facilities, and the hot cells facilitate work of experimenters. (auth)

15626 BIOLOGICAL SHIELDING [OF SILOÉ]. E. de Robien and G. Mitault. Bull. Inform. Sci. Tech. (Paris), No. 78, 85-90(Dec. 1963). (In French)

Biological shielding of Siloé is made up of successive thickness of water and concrete. Consideration was especially directed to radioactivity in the primary coolant. Radiation from N^{16} and Na^{24} is reduced by a deactivation tank and a warm layer on the surface of the swimming pool, respectively. Efficiency of this warm layer was demonstrated by the results given for operating experience at 10 Mw. (auth)

15627 ELECTRIC POWER AND VENTILATION SYSTEM [OF SILOÉ]. G. Mitault and J.-C. Faudou. Bull. Inform. Sci. Tech. (Paris), No. 78, 91-103(Dec. 1963). (In French)

The 15-kv electric power of Siloé is supplied from a central substation, which serves all the laboratories in the Center. The substation transforms primary 3-phase power from 15 kv to 380 to 220 v. Control installations are supplied from sets of rectifiers and batteries with 127 and 48 v direct current. If the normal electric power supply fails, a 12000 kva diesel driven generator is automatically started and in a very short time supplies power. The ventilation system supplies the whole building with conditioned air, holds the shell in negative pressure, and exhausts radioactive effluents. (auth)

15628 SILOÉ TESTS. M. Jacquemain and F. Merchie. Bull. Inform. Sci. Tech. (Paris), No. 78, 105-11(Dec. 1963). (In French)

The Siloé tests were executed in two phases: tests without neutrons and tests with neutrons. The former was aimed at checking the operation of different equipment, especially: dynamic tests of the primary cooling system, dismantling and reassembling tests of the core, and examination of the swimming pool water tightness. The latter tests included: low power tests (first divergence, rod calibration, antireactivity, thermal flux measurements) and power tests (ten Mw graduated rise). The results of the tests are indicated. (auth)

15629 CONTROL SYSTEM OF THE JEN-1 REACTOR. M. Fajardo Castillo and C. Martin Nuño (Junta de Energia Nuclear, Madrid). Energia Nucl. (Madrid), 7: 25-34(Oct.-Dec. 1963). (In Spanish)

The instrumentation of the JEN-1 reactor is briefly reviewed. The control and safety system is described in more detail. The characteristics and purpose of the shutdown circuit, fission-counter control, automatic-manual control, control rod circuit, drive of the pump motors of the primary, secondary, and purification systems, drive of the primary valve motor, principal control panel alarm, and auxiliary panel alarm are described. (J.S.R.)

15630 UTILIZATION OF THE JEN-1 REACTOR FOR THE PRODUCTION OF RADIOISOTOPES. Germán Dominguez Rodriquez and Manuel del val Cob. Energia Nucl. (Madrid), 7: 43-59(Oct.-Dec. 1963). (In Spanish)

The JEN-1 reactor has been used since 1957 for the pro-

duction of radioisotopes. The methods used for their production, analysis, activity determination, and distribution are briefly summarized. The use of radioisotopes in Spain and possible future developments are discussed. (J.S.R.)

15631 ACTIVATION ANALYSIS WITH THE JEN-1 REACTOR. Antonio Travesi Jiménez and Germán Dominguez Rodriguez. Energia Nucl. (Madrid), 7: 60-79(Oct.-Dec. 1963). (In Spanish)

The principle of activation analysis is briefly reviewed, and the experimental facilities constructed at the JEN-1 reactor are described. The factors to be considered in activation analysis, such as irradiation containers, flux control, interferences from fast neutrons, sensitivity, and data interpretation, are discussed. Typical uses of activation analysis are given as examples. (J.S.R.)

15632 FISSION PRODUCTS AS A SOURCE OF RADIOISOTOPES OF HIGH SPECIFIC ACTIVITY. Miguel Barrachina Gomez and German Dominguez Rodriguez (Junta de Energia Nuclear, Madrid). Energia Nucl. (Madrid), 7: 80-94(Oct.-Dec. 1963). (In Spanish)

After a brief review of the nature and origin of the fission products from thermal fission of U^{235}, the methods used in the separation and purification of the long-lived radioisotopes are described. The radioisotopes discussed are Cs^{137}, Sr^{90}, Ce^{144}, Pm^{147}, Ru^{106}, and Kr^{85}. The production of the short-lived fission products Y^{90}, Tc^{99}, Mo^{99}, I^{131}, I^{132}, Te^{132}, I^{133}, Xe^{133}, Xe^{135}, La^{140}, Ba^{140}, and Pr^{144} is also described. Studies on the adaptation of the usual methods for the preparation of fission radioisotopes to the operation of the JEN-1 reactor are indicated. (J.S.R.)

15633 SPERT PROGRAM STATUS REPORT. E. G. Silver. Nucl. Safety, 5: No. 2, 151-5(Winter 1963-64).

A review is presented of the SPERT experimental program from Jan. 1962 through March 31, 1963. SPERT-I, -II, -III, and -IV are reviewed in turn. The results led to further understanding of the mechanisms of reactivity compensation. The most outstanding result was the large delayed pressure transient in the SPERT-I destructive test. (D.L.C.)

15634 ORR FUEL FAILURE INCIDENT. A. L. Colomb and T. M. Sims. Nucl. Safety, 5: No. 2, 203-7 (Winter 1963-64).

A partial meltdown of one fuel plate in a 19-plate fuel element occurred at the ORR on July 1, 1963. An account is given of the sequence of events before and after the incident. Examination of the defective fuel element showed the cause of the incident to be a displaced gasket which prevented adequate cooling of the melted plate. Procedures adopted to prevent similar incidents in the future are described. (D.L.C.)

15635 UTILIZATION OF RESEARCH REACTORS. Proceedings held in Bangkok, December 17-21, 1962. (International Atomic Energy Agency, Vienna). 1963. 452p. STI/DOC/55 (IAEA)

Twenty-six papers presented at the Study Group Meeting on Utilization of Research Reactors are given. Separate abstracts were prepared for 25 papers. One paper was previously abstracted in NSA. (M.C.G.)

For abstracts of individual papers see: 13550, 13551, 13897, 13898, 14342, 14343, 15312, 15313, 15482, 15636, 15637, 15638, 15639, 15640, 15641, 15642, 15643, 15644, 15645, 15646, 15647, 15648, 15649, 15650, and 15651.

15636 ORGANIZATIONAL PROBLEMS CONCERNING NEW RESEARCH REACTOR CENTRES IN ASIA. R. Ramanna (Atomic Energy Establishment, Trombay, India). p.13-25 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Experience in the organization of research reactor centers in Asia is discussed. Chief problems are said to be lack of trained personnel and industrial development in the country. Government support and training of personnel are discussed. Research program planning is described. (M.C.G.)

15637 GENERAL PROBLEMS FACING THE NEW CENTERS. R. Wakabayashi (NAIG Research Lab., Japan). p.27-9 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

The development of a research reactor center is described. Selection of a site, convincing area residents of the safety of the reactor, and training experimenters and operators are discussed. (M.C.G.)

15638 NUCLEAR RESEARCH AT TROMBAY, ITS ORGANIZATION AND PROGRAMME. R. Ramanna (Atomic Energy Establishment. Trombay, India). p.35-41 of "Utilization of Research Reactor. " Vienna, International Atomic Energy Agency, 1963.

Research and developments in atomic energy at the Atomic Energy Establishment, Trombay, is described. The research programs in neutron physics, reactor physics, and chemistry are discussed. Instrument production activities are outlined. The facilities and the training program are described. (M.C.G.)

15639 SOME PRACTICAL PROBLEMS IN RESEARCH REACTORS OPERATION AND UTILIZATION. J. Bernot (Commissariat à l'Energie Atomique, France). p.43-57 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Problems encountered in organizing the operation and utilization of a research reactor are reviewed. Operational problems such as personnel, equipment, funds, and safety controls are discussed. The conditions under which a research program can be performed with the reactor are analyzed. Utilization of existing domestic resources (personnel, equipment, and funds) and foreign cooperation are discussed. (M.C.G.)

15640 OUTLINE OF AN ATOMIC ENERGY CENTER IN JAPAN (JAERI). K. Tomabechi (Japan Atomic Energy Research Inst., Tokyo). p.59-61 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Organization of JAERI, its employees, funds, facilities, training programs, and relations with companies and universities are discussed. (M.C.G.)

15641 BASIC INFORMATION ON THE KOREAN RESEARCH REACTOR PROJECT. Chang Kun Lee (Atomic Energy Research Inst., Seoul, Korea). p.63-72 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Planning and construction of the research reactor are reviewed. Organization of the center and its integration with the other research and education institutions of the country are discussed. The program for utilizing the reactor in physics, chemistry, biology, reactor engineering, electronics, and health physics studies is outlined. The power reactor project and utilization of radioisotopes are discussed. (M.C.G.)

15642 STATUS OF THE PHILIPPINE ATOMIC RESEARCH CENTER (PARC). Librado D. Ibe and Guillermo C. Corpus. p.73-85 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Selection and acquisition of a nuclear research reactor for the Philippine Atomic Research Center is discussed. The reactor chosen was of the swimming pool type, light-water cooled and moderated, graphite reflected, and fueled with 20% enriched U^{235}. Interim activities carried out during completion of the reactor project and the test program for the reactor facility are described. The program for utilizing the reactor facility is outlined. Integration of the center with other research and educational activities is discussed. (M.C.G.)

15643 THE RESEARCH REACTOR PROJECT OF PAKISTAN. M. N. Alam and S. Ahmed Hasnain (Atomic Energy Commission, Karachi, Pakistan). p.87-91 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

The Pakistan Institute of Nuclear Science and Technology (PINSTECH) is planned to be a national center for training, research, and development of practical uses of atomic energy. One of the major facilities will be a 5-Mw pool-type research reactor. Utilization of the reactor for production of radioisotopes, research and development, and training is planned. Support facilities for the research reactor are described. Collaboration between the Institute and outside organizations is discussed. (M.C.G.)

15644 SOME INFORMATION ON THE INDONESIAN ATOMIC ENERGY PROGRAM. Ping-Hok Ong (Institute of Tech., Bandung, Indonesia). p.93-4 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

The status of the program of the Institute of Atomic Energy of Indonesia is reviewed. A reactor center is under construction to accomodate a 250-kw TRIGA MARK II reactor. Programs planned for training and studies in physics, reactor physics, radiochemistry, radiobiology and agriculture, and medicine are discussed. (M.C.G.)

15645 OPERATING AND SAFETY PROBLEMS IN A RESEARCH REACTOR. J. A. Cox (Oak Ridge National Lab., Tenn.). p.101-56 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Operating principles, training methods, and safety precautions developed in use of ORNL research reactors are reviewed. Operating safety rules for the ORNL reactors are listed. Rules for management of the reactor control system are discussed, including requirements for instrumentation, testing, shim-rod dropping time, rate of control-rod withdrawal, and low-level instrumentation. Other topics covered include: movement of safety chambers, effects of radiation sources on fission chambers, safety devices, reactor maintenance, costs, training and personnel, procedures, incidents, safety evaluation of experiments, services required for experiments, tools for experiments, services of radiochemical laboratory, electric and mechanical shops, corrosion problems, containers and carriers, fuel, water system, personnel exposure, radiation monitoring equipment and procedures, control of contamination waste disposal, emergencies, and startup procedures for new reactor. (M.C.G.)

15646 SAFETY PROCEDURES FOR RESEARCH REACTORS AND THEIR EXPERIMENTS. B. L. A. Ellings (Dounreay Experimental Reactor Establishment, Caithness, Scotland). p.157-66 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Requirements of safety documents both for the reactor and experiments to be irradiated in it are outlined. Procedures by which reactors and experiments can be cleared are indicated. One scheme for rig clearance is described. (M.C.G.)

15647 ONE AND A HALF YEARS' EXPERIENCE WITH THE TSING HUA OPEN-POOL REACTOR (THOR) AND ITS UTILIZATION. V. Chen-Hwa Cheng, et al. (National Tsign Hua Univ., Taiwan, China). p.167-201 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

The Tsing Hua open-pool reactor (THOR) is described. Reactor calibration included critical core loading of different core configurations, control blade worth calibrations, flux mapping and power level calibration, reactivity measurements, temperature and void coefficient measurements, and studies of transfer function. Operator training, instrumentation, reactor pool, water system, and radiation level at 1 Mw operation are discussed. The radiation safety program is outlined, including reactor survey, personnel monitoring, environmental survey, waste disposal, safety and emergency procedures, and equipment. Utilization of the experimental facilities, production of short-lived radioisotopes, training, student research, and services for other institutions are discussed. (M.C.G.)

15648 OPERATIONAL EXPERIENCES WITH JRR-1. K. Kakihara and K. Tomabechi (Japan Atomic Energy Research Inst., Tokyo). p.203-6 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Operation of the Japan Research Reactor No. 1, a 50-kw homogeneous solution type, is described. Utilization, maintenance, troubles encountered, and future plans are discussed. (M.C.G.)

15649 REACTOR PHYSICS AND ENGINEERING. H. Kouts (Brookhaven National Lab., Upton, N. Y.). p.213-27 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

The usefulness of research in reactor physics and in reactor engineering at a small research center in Asia is discussed. Three reasons given are: that it is a good area for cooperation between universities and laboratories in training technical people, that operation of a nuclear reactor requires a readily available group of people who understand the functioning of it, and that the cost of nuclear power is now low enough for electricity produced this way to be important soon in the growth of developing countries. Research problems and manpower and equipment needs are considered. (M.C.G.)

15650 SOME METHODS FOR PRODUCING REACTOR PHYSICS DATA. J. L. Symonds (Australian Atomic Energy Commission, Lucas Heights, New South Wales). p.229-37 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Ideas and techniques for producing reactor physics data, which are used in the research and training program of the 10-kw Argonaut-type reactor MOATA, are described. The study theme is that of a high-temperature gas-cooled reactor based on beryllium oxide as moderator, thorium or natural uranium as fertile material, and one of the available fissile materials as fuel. The relation between theory and experiment, the slow chopper and determina-

tion of neutron energy spectra, integral spectrum studies, and reactivity change measurements are discussed. (M.C.G.)

15651 SOME COMMENTS ON A NUCLEAR PHYSICS PROGRAM AT NUCLEAR CENTERS IN DEVELOPING COUNTRIES. Ping-Hok Ong (Inst. of Tech., Bandung, Indonesia). p.287-9 of "Utilization of Research Reactors." Vienna, International Atomic Energy Agency, 1963.

Physics programs at nuclear centers in developing countries are discussed. Research programs and training are considered. (M.C.G.)

15652 OPERATIONAL EXPERIENCE OF THE SALUGGIA SWIMMING POOL REACTOR CONTROLLED BY A SOLUBLE POISON CLOSED LOOP AUTOMATIC CONTROL SYSTEM. G. Ambrosini, T. Bozzoni, and G. Cipollina (Comitato Nazionale Energia Nucleare, Rome). 24p. (CONF-243-49)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

An automatic fine control system is described where soluble poisons are circulated in a tube located in the reactor core. Boric acid is the neutron absorber and was used to control the Avogadro swimming pool reactor. The associated instrumentation is discussed. (R.E.U.)

15653 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Jules Horowitz and Victor Raievski (to Commissariat a l'Energie Atomique). British Patent 950,300. Feb. 26, 1964. Priority date May 20, 1960, France.

A swimming pool research reactor is described with means for handling samples to be irradiated. (R.E.U.)

WASTE DISPOSAL AND PROCESSING

Refer also to abstracts 13962, 14145, and 14424.

15654 (HW-74040) SAMPLING PROCESS WASTE SLUDGE IN UNDERGROUND STORAGE TANKS BY ROTARY CORE DRILLING. J. P. Duckworth, V. P. Kelly, J. D. Lodge, and J. R. Raymond (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 29, 1962. Contract AT(45-1)-1350. 15p.

A core driller was developed for coring hard sludge in underground tanks, and sludge samples were taken from the Purex 241-A-103 tank. The development, design, and operation of the drill are described. An electric conductivity probe was used to stop the drill when it contacted the tank bottom. Qualitative observations are given on the physical properties of the sludge in drilling tests. (D.L.C.)

15655 (HW-79622) FORMALDEHYDE TREATMENT OF PUREX RADIOACTIVE WASTES. R. C. Forsman and G. C. Oberg (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1963. Contract AT(45-1)-1350. 36p.

Continuous denitration of Purex acid waste (PAW) with formaldehyde was successfully demonstrated in a full-scale plant prototype unit in the Hanford Purex plant. The reaction is smooth and is easily and safely controlled. Because severe foaming can occur in the reaction vessel, the use of an antifoam agent is required to attain acceptable plant processing rates. Extensive laboratory and pilot plant work, proper equipment design, and satisfactory operating procedures were the bases for developing adequate safeguards that assure complete control of the reaction at all times. During operation, the formaldehyde and the preheated PAW stream (with 50 to 100 parts antifoam per million parts PAW) are added continuously to the reactor which is maintained at 95°C. From an initial feed concentration of approximately 6.1M, the free acid is reduced to 0.5 to 1.0M in the treated waste. About 2.5 moles of free acid are destroyed per mole of formaldehyde added to the unit for a 60% reaction efficiency. A decontamination factor of 10^4 from feed to recovered acid is typical, which means that the ratio of radioactivity to HNO_3 in the recovered acid is reduced by a factor of 10,000 when compared to the same ratio in the high activity waste (PAW). Formaldehyde denitration of the Purex acid wastes reduces the chemical costs of waste treatment and storage. In addition, the process increases the storage capacity of underground tanks because of less salts in the waste, increases the flexibility of waste treatment equipment, and improves the quality of feed for fission product recovery. (auth)

15656 (HW-SA-3333) CHARACTERIZATION AND APPLICATION OF ZEOLITES FOR RADIOACTIVE WASTE TREATMENT. J. L. Nelson, L. L. Ames, and B. W. Mercer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 13, 1964. Contract [AT(45-1)-1350]. 30p.

The various ways in which zeolites may be applied to radioactive waste treatment and disposal are described briefly. Some of the properties of zeolites studied are tabulated. Equilibrium and kinetic experiments were run on zeolites with Cs and Sr, and the results are presented. Experiments on actual applications of zeolites to synthetic and actual wastes were also made. Synthesis of zeolites is considered briefly. (D.L.C.)

15657 (NP-13685) REPORT OF THE OCEANOGRAPHIC SURVEY CARRIED OUT IN YOKOHAMA HARBOR WITH SOME CONSIDERATIONS ON THE DISPOSAL OF RADIOACTIVE WASTES FROM NUCLEAR POWERED SHIPS INTO THE MARINE ENVIRONMENT. Gensenkyo-34. (Nuclear-Powered Ship Research Assn. of Japan, Tokyo). Feb. 19, 1963. 90p.

Some aspects of radioactive wastes from nuclear powered ships, problems of the waste disposal, and hazards of nuclear powered ships are outlined. The results of the oceanographic survey carried out in Yokohama Harbor are given with the features of the tidal currents, the distributions of chlorinity, soluble silicates, and dissolved oxygen in the harbor water. The various theories of diffusion are outlined as a basis of considerations on the safety evaluation of the waste disposal into the marine environment sound. Bases for evaluating safe discharge rates of wastes from nuclear powered ships are described, and analytical descriptions of the experiments on diffusion of dye carried out in Santa Monica Bay, California, and Yokohama Harbor are also given. In the harbor water of Yokohama, the radius of the dye patch (r_0) is well expressed by $r_0^2 = 0.7\ t^2 \ln(\tau/t)$, where t is the time after the release of dye from an instantaneous point source and τ the time when the patch disappears is known from the observation. In the above equation t and τ are expressed in minutes and r_0 in meters. τ was estimated as 420 minutes in one case when the initial amount of dye was 1 kg. A summarized translation of a referred report relating to the disposal of radioactive wastes from nuclear powered ships into the marine environment is given. It is concluded that it is essential for a systematic oceanographic survey program to be initiated as soon as possible to establish the operating doctrine for nuclear powered ships. The program should be carried out by any Government agencies and cover whole of the appropriate inshore waters including harbors, the continental shelf, and the open sea. Reliable data of ocean and tidal currents, the exchange rate of sea water, the processes of dispersion of substance in the various localities of the marine environment are scarce at present, and also the concentration by marine organisms of the various significant isotopes in the wastes from nuclear powered ships, or the route by which such introduced activity would return to man from sea, are not yet studied sufficiently to meet the expected requirements relating to the operation of nuclear powered ships. (auth)

15658 (TID-7677(p.280-96)) REMOVAL OF PARTICULATES FROM WASTE CALCINING FACILITY OFF-GAS. R. D. Modrow, L. T. Lakey, and J. A. Buckham (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho).

The removal of particulate matter from off-gas from the Waste Calcining Facility (WCF), a unit that will convert radioactive liquid wastes to granular solids in a heated, fluidized bed is discussed. Descriptions of the off-gas cleaning equipment employed are given together with data for each unit. Also discussed are sampling of the off-gas for particulate matter and other special techniques used in evaluating the system performance. The overall decontamination factor for the off-gas cleanup system, consisting of a cyclone, a spray tower, a venturi scrubber and separator, silica gel beds, and AEC filters, was about 3.6×10^9. This resulted in a reduction of the solids loading from approximately 1.4 to about 5×10^{-4} grains/acf; par-

ticulates in the final off-gas were essentially spherical and were less than 0.1 micron in diameter. This high degree of decontamination indicated that a noncondensing-type cleanup system can be used to reduce radioactive particulate contamination in a gas stream to a level low enough to permit the gas to be released safely to the atmosphere. The use of a radioactive tracer in the system indicated the occurrence of a delayed-type of penetration of the AEC filters by the submicron particles. About ten days were required to reach an equilibrium value of penetration through the filters. (auth)

15659 (TID-7677(p.331-47)) A RADIOACTIVE WASTE INCINERATOR. Ernest W. Bloore and David G. Lachapelle (Army Nuclear Defense Lab., Edgewood Arsenal, Md.).

A 50 lb/hr incinerator for the concentration of low-level radioactive combustible waste was designed and fabricated. The experimental facility utilizes auxiliary gas firing to maintain high combustion gas temperatures of 2,000 to 2,500°F, and dry collection methods for gas cleaning. An evaluation program is being initiated. (auth)

15660 (CEA-tr-A-1413) PROCEDE DE SOLIDIFICATION, DE DEFORMATION ET DE PROTECTION CONTRE LES RAYONNEMENTS DES DECHETS RADIOACTIFS. (Process of Solidification, of Deformation, and of Protection Against Radiations of Radioactive Waste). H. Wiedmann. Translated into French from German Patent 1,071,246. [nd]. 6p.

A procedure that permits the transformation of radioactive wastes into bodies giving no difficulties in transport or storage is described. The solid, liquid, or sludge radioactive wastes are incorporated into bituminous materials used as binders. The bituminous materials are used in the form of emulsions. Substances that ensure improved solidification and/or that shield against the radiation are added to the radioactive wastes. (J.S.R.)

15661 RADIOISOTOPE INCORPORATION INTO FUSED SILICATE MELTS. (THE INVESTIGATION OF Sr AND Cs ELUTION AND DIFFUSION. Jarmila Rálková and Jaroslav Saidl (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jaderna Energie, 10: 14-18(Jan. 1964). (In Czech.)

The applicability of various materials for the fixation of high level wastes was investigated. Fused basalts or usual glasses were found to be the most convenient. Radioisotope elution and diffusion in these materials was investigated. The elution mechanism of silicate glasses is discussed and precautions for safe high-level waste storage are suggested. (auth)

GENERAL AND MISCELLANEOUS

15662 (AEEW-R-316) IMPULSE RESPONSE MEASUREMENTS WITH AN OFF-LINE CROSS CORRELATOR. E. R. Corran and J. R. Cummins (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Nov. 1963. 38p.

The impulse responses of simulated systems have been computed by off-line cross-correlation of the system input and output signals. The input test signal consisted of a discrete interval binary code whose autocorrelation was a triangular pulse at zero lag. The main object of the experiments was to study the inaccuracies introduced in ideal, noise-free systems by determining the impulse response digitally from sampled versions of the system input and output signals. A second object was to determine the error introduced by adding controlled amounts of uncorrelated noise at the system outputs. The experimental results showed that for signal-to-noise ratios greater than 10:1 in the mean square sense, the impulse responses may be determined with reasonable accuracy using only one cycle of the binary code. The method lends itself to on-line computation of system impulse responses. The latter could be used to monitor the stability of the system or to determine control parameters in an adaptive control system. (auth)

15663 (ANL-6808) REACTOR DEVELOPMENT PROGRAM. Progress Report, November 1963. (Argonne National Lab., Ill.). Dec. 15, 1963. Contract W-31-109-eng-38. 86p.

Development progress is reported on fast reactors, liquid metal cooled reactors, ZPR-III, ZPR-VI, ZPR-IX, Borax-V, Faret, EBR-I, EBR-II, Treat, Fermi Fast Breeder Reactor, critical assemblies, Argonne Fast Source Reactor, EBWR, Argonne Advanced Research Reactor, magnetohydrodynamic cells, fuel cells, and boiling water reactors. Reactor technology is reported on fuel development and properties, physics, heat engineering, materials development, chemical separations, nuclear safety, and nondestructive testing. (N.W.R.)

15664 (BMI-1655(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING OCTOBER 1963. Russell W. Dayton and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Nov. 1, 1963. Contract W-7405-eng-92. 77p.

Progress is reported on developments relating to civilian applications in reactor materials and components, studies of fuels, fuel element fabrication, coated-particle fuel materials, fission-product deposition studies, irradiation of materials and components, gas-cooled reactor program, joining of regenerative cell components, corrosion and oxidation studies, radioinduced polymerization and reactions, and fuel element burnup. (N.W.R.)

15665 (BNL-6925) THE STUDY OF MENSTRUAL AND OTHER BLOOD LOSS, AND CONSEQUENT IRON DEFICIENCY BY Fe^{59} WHOLE BODY COUNTING. D. C. Price, E. M. Forsyth, S. H. Cohn, and E. P. Cronkite (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT-30-2-GEN-16. 18p.

An established method for determining radioiron absorption by whole body counting was used to study six parous women with hypochromic anemia and menorrhagia, and a seventh nulliparous woman with normal blood values and normal menses. In addition to demonstrating iron deficiency by increased radioiron absorption, the method was found useful in estimating the quantity of blood lost with each menstrual period. As much as 550 ml of menstrual loss was noted in two of the patients studied. Estimates in the patient with normal menses were 59 and 33 ml. Two additional patients demonstrated patterns of blood loss found in continuous gastrointestinal hemorrhage due to hereditary hemorrhagic telangiectasia, and in severe epistaxis, as further applications of the technique. Where available, the method is to be recommended for routine investigation of hypochromic anemia when episodic or continuous blood loss such as that of menorrhagia is suspected. (auth)

15666 (BNL-6942) BODY RETENTION OF HYDROXOCOBALAMIN AND CYANOCOBALAMIN. Lewis M. Schiffer, David C. Price, Stanton H. Cohn, and Eugene P. Cronkite (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 11p.

Hydroxocobalamin has been suggested as a replacement for cyanocobalamin as a vitamin B_{12} compound for the treatment of pernicious anemia. Studies in patients with pernicious anemia given Co^{60}-labeled cyanocobalamin or Co^{58}-labeled hydroxocobalamin, and followed for over 200 days by means of whole-body counting with a γ spectrometer, showed that the two compounds have similar biologic half lives once absorption is completed. (C.H.)

15667 (BNL-6945) INTRACELLULAR DISTRIBUTION OF TRANSKETOLASE AND TRANSALDOLASE IN A PHOTOSYNTHETIC ORGANISM. Robert M. Smillie (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 6p.

Transketolase is an essential enzyme of that part of the photosynthetic carbon reductive cycle that regenerates pentose phosphate. Transketolase together with transaldolase catalyzes sugar rearrangements outside the chloroplasts as part of the oxidative pentose phosphate cycle. Results are reported from studies on the intracellular distributions of transketolase and transaldolase in the algae Euglena gracilis in which $C^{14}O_2$ was used as a tracer. The results indicate that while transketolase is located in chloroplasts, transaldolase is not. (C.H.)

15668 (BNL-7787) EFFECTS OF CHRONIC EXCESS SALT INGESTION. EXPERIMENTAL HYPERTENSION IN THE RAT, CORRELATION WITH HUMAN HYPERTENSION. Lewis K. Dahl (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT(30-2)-Gen-16 . 37p. (CONF-397-1)

From International Symposium on Epidemiology of Hypertension, Chicago, Feb. 1964.

Results are reported from a study of hypertension in rats. Variables investigated included excess salt (NaCl) ingestion, genetic factors, sex, and age. The data indicate that excess salt ingestion unmasked the hypertensive trait in genetically sensitive animals. The influence of age was found to be apparent rather than real and the result of the longer time over which noxious environmental factors exert their influence on blood pressure in individuals with varying degrees of susceptibility. Correlation of the data with human hypertension data is discussed. (C.H.)

15669 (CONF-204-5) THE SCATTERING OF LATTICE VIBRATIONS BY VACANCY TYPE DEFECTS. James A. Krumhansl (Cornell Univ., Ithaca, N. Y. Lab. of Atomic

and Solid State Physics). [1963]. Contract AT(30-1)-2179. 42p.

From International Conference on Lattice Dynamics, Copenhagen, Aug. 1963.

The development of the subject of lattice defects in solids is reviewed, and the relation of lattice defects to field theory is discussed. The defect is regarded as a particle imbedded in the phonon field. Specific application is then made to a defect in a simple cubic crystal including interactions between the defect site and its six nearest neighbors. Scattering solutions and scattering cross sections are obtained and show that vacancies can cause strong resonant scattering, or pseudolocalized modes, at frequencies well below the Debye frequency. Applications to thermal conductivity and other experiments are discussed briefly. (auth)

15670 (CONF-408-1) THE ATOMIC ENERGY COMMISSION AND NUCLEAR EDUCATION. Russell S. Poor (Division of Nuclear Education and Training, AEC). [1963]. 20p.

From Interrelated Role of Federal Agencies and Universities in Nuclear Education Conference, Gatlinburg, Tenn., Aug. 1963.

The history of the development of the formal educational activities of AEC is summarized briefly. The establishment of the Division of Nuclear Education and Training is discussed. The role of AEC laboratories in the educational program is discussed. Major problems in the program are considered, and several solutions for these problems are suggested. (D.L.C.)

15671 (CONF-411-1) FOLIAR APPLICATION OF FERTILIZER. S. H. Wittwer (Michigan State Univ., East Lansing). [nd]. Contract AT(11-1)-888. 16p.

From 2nd Symposium for Farm Editors, Muscle Shoals, Ala., Sept.-Oct. 1963.

Developments in the foliar application of fertilizer are reviewed. Topics discussed include techniques and methods for the measurement of foliar absorption of fertilizers, plant processes associated with the foliar absorption and transport of nutrients from leaves to other plant parts, the correction of nutrient deficiencies by foliar sprays, and limitations in the foliar applications of fertilizers. (C.H.)

15672 (HW-80934) HIGH-ENERGY-RATE FORMING—A TITLE LIST. M. E. Hasbrouck, comp. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 14, 1964. Contract AT(45-1)-1350. 11p.

A bibliography of 64 references is presented on high-energy-rate forming and compaction in metalworking. The references are mostly to literature and reports available to industry, and cover the period 1962 to 1964. The references are grouped as follows: review and general articles, explosive forming, electric discharge forming, and pneumatic-mechanical forming. (D.L.C.)

15673 (IDO-16923) MATERIALS TESTING REACTOR-ENGINEERING TEST REACTOR TECHNICAL BRANCHES. Quarterly Report No. 8, July 1–September 30, 1963. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Feb. 15, 1964. Contract AT(10-1)-205. 64p.

Sample fuel platelets containing U_3O_8, UO_2, or UAl_3 in aluminum matrices were irradiated in the ETR at initial surface temperatures of 180°C to burnups of 1×10^{21} fiss/cm^3. The high fuel loadings (approximately 35 wt % U^{235}) in UO_2 and U_3O_8 blistered under these conditions; the UAl_3 samples were still in good condition at the end of the test. Electrolyzed coatings on aluminum deteriorated badly under exposures of 3 to 5×10^{20} n/cm^2 (>1Mev) in the ETR process water. The ARMF-1 regulating rod was repaired and digital regulating rod position readout instrumentation installed during an extended shutdown after more than two years of operation. Fission product transient curves extrapolated to about the same zero time reactivity value with initial data varying from 30 minutes to 6 hours. This limited considerably the probability that short-lived high cross section fission products exist. Under present ETR operating conditions the maximum decrease in effectiveness of a nickel absorber section as a result of burnup would be less than 20% in 20 years. Thus, burnup appears not to be a factor which limits its useful life. The preliminary analysis and flow charts for the Phillips General Purpose Monte Carlo Program for the IBM 7040 are nearing completion. Two reactor simulation devices were put into service in the Analog Computer Facility, a reactor kinetics simulator and seven transport lag simulation channels. Preliminary design of a Xe-135 simulator was completed. The fission cross section of Pu^{241} was measured from 2 to 100 ev. Resolution of the linear electron accelerator used was sufficient to permit multilevel analysis of the neutron levels below 36 ev. Transmission measurements were obtained on a separated Pa^{233} sample containing approximately 10 mg of Pa_2O_5. The energies of these resonances observed with the unseparated sample with their relative sizes are presented. Several experiments were conducted to determine the useful lifetime of solid state detectors under in-pile conditions of fission fragment bombardment. A single detector, using an external U^{235} fission source was irradiated to $\approx 3 \times 10^9$ total fission, at which point the fission fragment peaks were still well resolved and the signal pulses were sufficiently large compared to noise level so that the latter could be effectively biased out. Averaged reduced partial differential scattering cross sections for a powder Be sample were obtained. A Data Processing System for transient data was developed for use in the SPERT reactor complex. Data are recorded on an FM tape system and applied to a magnetic memory for temporary storage and from there to one or more of several readout devices. An Eight-Input Adapter and an Initial Delay Counter were developed to increase the utility of an existing time-of-flight analyzer. A Personnel Monitor ("Frisker") is described, which approaches closely an ideal monitor for use with widely varying radiation backgrounds. Current feedback around an operational amplifier is used to provide a current source used to drive oscillograph galvanometers thereby extending the range of linear operation of the galvanometers. The work of placing a large telemetered radiological survey system in operation is described along with the description of a remote station simulator. Dynamic pressure tests of several commercial transducers are described together with the criteria established for suitability for their use in reactor transient studies. Rod drop deceleration times were measured on an ETR control rod; the test instrumentation is described. The 7090 version of PDQ-4 (20,000 mesh points) was converted and modified for operation on the 7040. The following reactor codes are also now in operation on the 7040: TEMPEST-II, GAM, FOG, ZUT, MIST, ULCER, and TOPIC. Being de-bugged are HEAT-I and IREKIN. In addition, the following programs for the 7040 were written and placed in operation: matrix inversion, ordinary differential equations, double precision arithmetic, linear least squares fitting, numerical integration subroutines, and CalComp plotter output. The simulator program for the IBM-650 also is now operating routinely on the 7040. (auth)

15674 (IMM-NYU-316) NONLINEAR BUCKLING OF RECTANGULAR PLATES. Louis Bauer and Edward L. Reiss (New York Univ., New York. Courant Inst. of Mathematical Sciences). Dec. 1963. Contracts AT(30-1)-1480 and Nonr-285(42). 47p.

The nonlinear deflections of a thin elastic simply supported rectangular plate are studied. The plate is deformed by a compressive thrust applied along the short edges. For the boundary value problem considered, it is proved that the plate cannot buckle for thrusts less than or equal to the lowest eigenvalue of the linearized buckling problem. For larger thrusts, approximate solutions of the von Kármán equations are obtained by an accelerated iteration method. Each iterate is numerically evaluated by a finite difference procedure. Using this method, approximate solutions are obtained for thrusts considerably larger than the lowest eigenvalue. These solutions bifurcate from the eigenvalues of the linearized problem. In addition, an asymmetric solution is found which appears to branch from a previously bifurcated solution. The extensive numerical results are used to study the formation of boundary layers and the related problem of the plate's ultimate load. On the basis of the numerical results, an energy mechanism is proposed to explain a "mode-jumping" phenomenon which has been previously observed in experiments. (auth)

15675 (IS-530) CHEMICAL BINDING IN THE WATER MOLECULE. Clyde Edmiston and Klaus Reudenberg (Ames Lab., Ames, Iowa). Aug. 14, 1962. Contract W-7405-eng-82. 79p.

Studies were made of chemical binding in H_2O. Conclusions substantiated the views that were reached in the cases of H_2 and H_2^+ molecules. These hold that the shift of charge into the bond region, which accompanies binding, leads to a strong drop in kinetic energy, but little or no decrease in potential energy. Partitioning according to physical concepts and according to atomic orbitals is discussed. (M.C.G.)

15676 (IS-641) REINVESTIGATION OF THE CC STRETCHING AND CH_3 ROCKING ASSIGNMENTS IN ISOPROPYL AND TERT.-BUTYL HALIDES. R. P. Hirschmann and R. N. Kniseley (Ames Lab., Ames, Iowa). Apr. 5, 1963. Contract W-7405-eng-82. 6p.

During the course of an investigation of the spectra of alkyl thiocyanates, certain anomalies appeared in the assignments of the c-c stretching and methyl rocking vibrations in isopropyl and t-butyl halides. Vibrational assignments previously proposed by Sheppard are given and changes suggested. (M.C.G.)

15677 (IS-654) TRIMETHYLLACTAMIDE. Jack E. Powell (Ames Lab., Ames, Iowa). May 9, 1963. Contract W-7405-eng-82. 4p.

A method is given for the preparation of trimethyllactamide (butyramide, $\beta\beta$-dimethyl-α-hydroxy-). Pivaldehyde is reacted with sodium bisulfite. Sodium cyanide solution is added. The two-phase mixture is allowed to separate and crude pivaldehyde is separated from the water phase. HCl is bubbled through the mixture and pivaldehyde cyanohydrin is converted to the hydrochloride of trimethyllactamide. The hydrochloride is dissolved in water, the solution neutralized, and trimethyllactamide allowed to precipitate. (M.C.G.)

15678 (IS-790) VAPOR PRESSURES OF SOME AMINO ACIDS. Dale Dean Clyde and Harry Svec (Ames Lab., Ames, Iowa). Nov. 1963. Contract W-7405-eng-82. 37p.

The vapor pressures of several amino acids were determined by the Knudsen cell effusion method. The standard thermodynamic quantities for the heat of sublimation, the entropy of sublimation, and the free energy of sublimation are calculated. The sensitivity of the mass spectrometer is calculated for an amino acid from its vapor pressure, its ionization cross section, and its intensity of the $(P-COOH)^+$ ion currents relative to the total ion intensity. (auth)

15679 (IS-835) THERMAL CONDUCTIVITY OF SILICON AND IRON FROM 300 TO 1400°K. A. H. Klein, H. R. Shanks, and G. C. Danielson (Ames Lab., Ames, Iowa). Oct. 1963. Contract W-7405-eng-82. 17p. (CONF-412-1)

From Thermal Conductivity Conference, Gatlinburg, Tenn., Oct. 1963.

The thermal diffusivities of pure silicon and of Armco iron were measured from 300 to 1400°K. The specific heats of the same materials were measured over the same temperature range. The thermal conductivity was obtained from the product of the thermal diffusivity, specific heat, and density. At 1400°K, the contribution of bipolar diffusion to the total thermal conductivity of silicon was 16 per cent and the contribution of lattice vibrations was 84 per cent. The Gruneisen constant was 1.89. The data on Armco iron are in general agreement with thermal conductivity data reported by other investigators. (auth)

15680 (LADC-5733) ON THE LOCALIZED MODE IN AN ANHARMONIC CRYSTAL. William M. Visscher (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract W-7405-eng-36. 25p.

An exactly soluble model for the anharmonic crystal is studied. A truncated cubic anharmonic interaction is used which, in lowest order perturbation theory, gives results identical to those of the usual anharmonic theory. Numerical results are given for the lifetime of the localized mode in a simple cubic lattice with a light isotopic impurity. (auth)

15681 (LADC-5738) EFFECT OF CORIOLIS INTERACTION ON THE THERMODYNAMIC FUNCTIONS OF SYMMETRIC TOP MOLECULES. Robin S. McDowell (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 6p.

The first-order correction to the partition function due to Coriolis interaction (vibrational-rotational angular momentum coupling) is calculated for symmetric top molecules. The magnitude of the effect on the thermodynamic functions is illustrated with the heat capacity of CH_3D. (auth)

15682 (LADC-5746) CULTIVATION AND SLIDE PREPARATION OF MAMMALIAN PERIPHERAL BLOOD LEUKOCYTES. Gretchen L. Humason and Phyllis C. Sanders (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 6p.

The increased interest in chromosome abnormalities induced by ionizing radiation prompted an investigation of present technical methods for preparing chromosomes for study. A reliable and simple method without sacrificing the subject is required to assure good metaphases numerous enough for statistically valid correlation with radiation dosages. The method as developed, a modification of Moorhead's (1960), has been used with success for several types of mammalian chromosomes, including those of human, dog, monkey, and rat leukocytes. A culture from peripheral blood of a chicken also was successful. (auth)

15683 (LADC-5749) IDENTIFICATION OF IMPURITIES IN α-TRINITROTOLUENE BY THIN LAYER CHROMATOGRAPHY. Stanley K. Yasuda (Los Alamos Scien-

tific Lab., N. Mex.). [1961]. Contract [W-7405-eng-36]. 14p.

A two-dimensional thin layer chromatography method, capable of separating and identifying the impurities in α-TNT, is described. A unique developing method is used in which a zinc reductor is incorporated directly in the thin layer. p-Diethylaminobenzaldehyde is condensed with the reduced product to obtain the color-developed spot. The impurities commonly occurring in TNT are readily identified by means of this procedure and are found to be the dinitro- and trinitro-toluenes. In addition, an unexpected impurity, α-nitroTNT, was found in one sample of TNT. (auth)

15684 (LADC-5755) RBC VOLUME CHANGES RESULTING FROM NONPHYSIOLOGIC pH. C. C. Lushbaugh, E. C. Anderson, H. I. Israel, D. B. Hale, and N. J. Basmann (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract [W-7405-eng-36]. 9p.

The reported increased size of erythrocytes suspended in saline is due to an effect of the low pH of unbuffered saline solutions commonly used in electronic particle counters. This increase in size was found to occur exponentially with decrease in pH and to be 10.6 and 12.5 percent per pH unit below 7.4 for man and mouse, respectively. The derivation and use of this fractional change as a correction factor for converting RBC volumes measured electronically at an arbitrary pH to cubic microns at physiologic pH are described. (auth)

15685 (LADC-5764) HAZARDS FROM MASERS. T. E. Ehrenkranz and H. F. Schulte (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 3p.

Results of experiments on rabbits indicate that lasers and masers could produce eye damage even at distances of several miles if one looked directly into the beam. Retinal burns and subcutaneous skin burns are reported in persons working with lasers. The possibilities of electric shock and x radiation from the power source are discussed. (C.H.)

15686 (LADC-5774) ON SUBLINEAR OPERATORS IN HILBERT SPACE WITH UNIFORMLY SYMMETRIZABLE DERIVATIVES. George H. Pimbley, Jr. (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract [W-7405-eng-36]. 41p.

Some existence and uniqueness theorems for the solutions of eigenvalue problems of the form $T(x) = \lambda x$, where $T(x)$ is a sublinear operator and λ is a real parameter, are proved. (D.C.W.)

15687 (LAMS-3027) AN EXAMINATION OF A MODEL OF A SEARCH BY THE SENSE OF "SMELL." M. H. Goldhaber (Los Alamos Scientific Lab., N. Mex.). Feb. 1963. Contract W-7405-eng-36. 24p.

A scalar field is given in space. It is interpreted as an intensity of a quantity like smell, e.g., density of some molecules, in the simplest case emanating from a (stationary or moving) point source. An object (a macromolecule or an insect) tries to locate the source (another molecule in a cell, or a source of food). It is a moving object, and its inertia of motion or flight makes it impracticable to determine in each point the steepest descent and follow the gradient. What is an economical or practical strategy of search? Some elementary results are obtained for a two-dimensional version of the problem. (auth)

15688 (MLM-1152) MOUND LABORATORY PROGRESS REPORT FOR MARCH 1963. J. F. Eichelberger, G. R. Grove, L. V. Jones, and E. A. Rembold (Mound Lab., Miamisburg, Ohio). Mar. 30, 1963. Contract AT(33-1)-Gen-53. 22p.

Using six hot-wire columns and three concentric tube thermal diffusion columns a cascade system was arranged to produce 0.04 g of 90% C^{13} per day using methane as the feed gas. The ten liter shipment of purchased methane enriched to 60% C^{13} was received. This gas will be enriched to 90% C^{13}. Before removing the equilibrated gas from the concentric tube columns in preparation for using methane enriched in C^{13} as feed material, a sample of methane taken from the bottom of the last column contained greater than 65% C^{13}. The hydrolysis of protactinium was found to be completely controllable and reversible and can serve as the basis for its separation from other elements, particularly its decay products. The tendency to hydrolyze is not a unique characteristic of protactinium, but is exhibited, under appropriate conditions, by Th^{227} and Ra^{223} at trace levels. Traces of protactinium in 1N H_2SO_4 can be removed from solution by a coarse glass wool filter through which the decay products pass readily. The reverse is true if the H_2SO_4 concentration is increased to 6N. The desorption of protactinium from platinum was a function of the reagent, the reagent concentration, and the amount of protactinium adsorbed. The relative solubility of protactinium in various reagents increased in the order: $HNO_3 < HCl < H_2SO_4 < H_2C_2O_4 < HF$. Equations for computing the growth of the principal alpha-emitters in the Ac^{227} decay chain were recalculated based on the recently redetermined half lives of Ac^{227}, Th^{227}, and Ra^{223}. Several laboratory experiments on waste disposal problems indicated that radioactivity levels in influent water can be significantly reduced by precipitating aluminum hydroxide as well as bismuth hydroxide in the hydrolysis cell. The aluminum hydroxide effectively removed Zn^{65} from the influent water (Zn^{65} is a major radioactive impurity in irradiated aluminum cans from the polonium process). The solubility product constant of potassium plutonium sulfate in lithium sulfate was determined to be $5.00 \pm 0.33 \times 10^{-18}$. Additional measurements were made on the "stretching effect" using a quasi-calorimeter built for this purpose. The stretching effect is a change in the thermal properties of materials of construction believed to be related to the coefficient of thermal expansion. Styrofoam for example, has a large "stretching effect," Lucite has almost none. (auth)

15689 (MLM-1155) MOUND LABORATORY PROGRESS REPORT FOR APRIL 1963. J. F. Eichelberger, G. R. Grove, L. V. Jones, and E. A. Rembold (Mound Lab., Miamisburg, Ohio). Apr. 30, 1963. Contract AT(33-1)-Gen-53. 43p.

Tensile strength and percentage elongation data for ten anhydride-cured epoxy and three polyol-cured polyurethane adhesive formulations, which were aged for 12 months at ambient temperature, were obtained at –65°F, room temperature, and 160°F. These data showed that little or no degradation of the adhesive formulations took place during the 12-month period. Flexible conductive adhesives were formulated with carbon black and silver fillers. These polyurethane formulations were heated to 160°F to determine whether the electrical resistance changed as a result of heating. The addition of carbon black to the formulation decreased the electrical resistance and increased the bond strength of the silver-filled formulation. Five fillers (two graphite, one carbon, and two powdered silica) were incorporated into diallyl phthalate formulations for experimental molding powders. Molded test specimens of these formulations were evaluated for tensile strength, percent-

age elongation, heat distortion temperature, impact strength, and arc resistance. The graphite and carbon-filled formulations had no appreciable increase in impact strength over the standard asbestos-filled material; however, they had higher tensile strengths and heat distortion temperatures. Silica-filled moldings had physical characteristics similar to the asbestos-filled plastic, but the formation was unsatisfactory due to inclusions. The relative yields of Po^{208} and Po^{209} in reactor-produced Po^{210} were redetermined by counting methods with greater accuracy than previously reported. A sample of Po^{208} was returned from Argonne National Laboratory. The sample contained about 15 μC of Po^{208} and will be used for accurately determining the half life of that isotope. Two ion exchange procedures were developed for that purification of this polonium sample. Single gamma spectra were obtained for two different sources containing mixtures of Po^{208} and Po^{209}. Prominent gamma energies were found at 75, 130 to 140, 260, 580, and 900 kev. The 75 kev peak is characteristic of x-ray spectra of polonium. Coincidence data are being obtained to assign the various radiations and nuclear energy levels to each of these isotopes. The decontamination factors obtained with the various treatments of wastes from the polonium process were investigated. Samples of a typical waste solution were treated by precipitation of various metal hydroxides at different pH levels. The alpha, beta, and gamma activities were measured and compared with the activity of the original solution. A single treatment of the waste will not lower the activity of the waste to an acceptable level. A decontamination factor of 4,000 will be required to reduce the activity sufficiently. The feasibility of using Ac^{227} as a radioactive heat source was estimated from product data and from the power level of the isotope. The chief drawback to the use of Ac^{227} is the limited supply of Ra^{226} that can be irradiated. The half life of Ac^{227} was recalculated, giving a value of 21.7714 (+0.0056, −0.0033) years. The half life is based on data gathered over the last ten years. The growth and decay factors for alpha emitters in the Ac^{227} decay chain were recomputed on the basis of the half life values of Ac^{227}, Th^{227}, and Ra^{223}. Decay tables were developed for the decay of Ac^{227}, Th^{227}, and Ra^{223} and for the growth of alpha activity from initially pure Ac^{227} and pure Th^{227}. Differential decay data were obtained for the residue adsorption fractionation of Ac^{227}, Th^{227}, and Ra^{223} in nitric and hydrofluoric acids. Preliminary work on a sequential residue adsorption separation of Pa^{231} and its principal decay products was completed. The residue adsorption technique is useful for the preparation of alpha sources having improved characteristics as standards. The power growth curve for U^{232} was calculated. Two methods for separating and purifying U^{234} from aged Pu^{238} solutions were investigated at the tracer level. The plutonium was first reduced to the trivalent form (by ferrous sulfamate in the first procedure and by hydroxylamine in the second. Then the uranium was eluted from plutonium on Dowex 1X4 anion exchange resin. Plutonium remained on the resin. At the low plutonium concentrations used, difficulty was experienced in accurately counting the plutonium which remained on the resin; however, both methods gave satisfactory separation of U^{234} from the plutonium solution. The absolute accuracy for the analysis of tritium in He^3 by internal geiger counting was checked against a 53.84 at. % tritium standard (as determined by mass spectrometry) and found to be within the precision of the method (1.25%). Since He^3 does not exhibit the phenomenon of superfluidity below the lambda point, attempts are being made to separate the helium isotopes by use of this principle. Preliminary attempts at separation by filtration were unsuccessful. Carbon monoxide and methane are being evaluated as feed materials for purifying C^{13} by thermal diffusion. A feed product with 60.86% C^{13} in the total carbon was purified in two 24-ft concentric-tube columns; the bottom product contained 91.46% C^{13} in the total carbon. Three runs were made on the methane purification system. In one run methane was enriched from 99.0% in the feed to 99.9% in the product. Two runs were made in the thermal decomposition studies using a carbon-sheathed Nichrome V wire. There was a 0.47 and 1.04% decomposition of carbon monoxide. A 12-foot Nichrome V thermal diffusion column wire was heated by alternating current. As the current increased, the wire vibrated. There was no visible vibration, however, when the wire was heated or cooled rapidly. A literature search was made to determine methods for predicting equilibrium constants for chemical exchange. Mathematical calculations of these constants were made for simple molecules. Four different methods were considered for enrichment of C^{13}. The bicarbonate method was cheap and simple; however, the reaction rate was slow. With monoethanolamine and carbon dioxide, separation factors of 1.004, 1.008, and 1.046 were obtained as reported in the literature. In a third method $HC^{13}N$ was formed; toxicity, high cost, and HCN polymerization were disadvantages of this technique. A carbon dioxide–carbon monoxide system had a single-stage separation factor of 1.086; difficulty was encountered in overcoming the slow reaction rate of this method. A theory of the operation of the thermal diffusion column was developed. Three equations were written based on the assumption that the column is in a quasi-stationary state and the convective velocity is in the vertical direction only. The $\Omega^{(22)*}$ (T) collision integrals were calculated for the helium potential function from 100° to 2000°K at 100-degree intervals. A nondestructive method for determining total beryllium in powdered beryllium samples by gamma activation was investigated. A standard curve was made, and duplicate analyses on various beryllium samples were determined. The method had a precision of better than ±0.2%. (auth)

15690 (NP-13686) CAPABILITIES IN NUCLEAR WEAPONS EFFECTS RESEARCH. (Waterways Experiment Station, Vicksburg, Miss.). 1963. 14p.

Facilities of the Nuclear Weapons Effects Research Section of the Hydraulics Division, Waterways Experiment Station, include: explosive casting molds, shock tubes, loading devices, and dynamic load generators. Services provided by the section in support of full-scale nuclear weapons testing include: (1) geologic studies and analysis of earthwork problems, (2) soils explorations and testing including subsurface explorations by rotary drilling methods, (3) soil analysis and backfill control, (4) complete grouting services including equipment for drilling grout holes, and batching, mixing, and injection of grout in the field, (5) blast and shock phenomena measurement, (6) measurement and analysis of the response of structure to structural components to blast or shock phenomena, and (7) measurement of crater size and shape, debris distribution, and delineation of plastic-elastic response boundary. (auth)

15691 (ORNL-3563) THE EFFECT OF THE "TENDENCY TO REPORT INJURIES" ON MINOR ACCIDENT STATISTICS: A FOLLOW-UP STUDY. J. E. Sergent (Oak Ridge National Lab., Tenn.). Feb. 1964. Contract W-7405-eng-26. 59p.

Thesis submitted to Univ. of Tennessee, Knoxville.

Statistical methods were used in an attempt to determine the effect of the tendency to report accidents on the systemic variance in minor injury data over a 6-yr period. The population surveyed included 245 journeymen of 9 skilled craft groups continuously employed during the period. Results indicate that injury and non-injury visits to the dispensary were relatively stable during the 6-yr period and that there was a significant positive relation between non-occupational and injury visits during the period of study. (C.H.)

15692 (ORNL-3581) INTRIGUE, AN IBM-7090 SUBROUTINE PACKAGE FOR MAKING LINEAR, LOGARITHMIC AND SEMILOGARITHMIC GRAPHS USING THE CALCOMP PLOTTER. M. B. Emmett (Oak Ridge National Lab., Tenn.). Mar. 1964. Contract W-7405-eng-26. 16p.

An IBM-7090 subroutine package has been written to facilitate the plotting of curves and points on linear, logarithmic, and semilogarithmic graphs using the CALCOMP plotter. The subroutines accomplish the necessary computations and prepare a magnetic tape for use by the plotter. (auth)

15693 (SC-R-64-105) THE GRAY AREA OF INTENT. E. S. Roth (Sandia Corp., Albuquerque, N. Mex.). Jan. 1964. Contract [AT(29-1)-789]. 13p. (CONF-400-1)

From American Ordnance Association 19th Annual Meeting, Standards and Metrology Division, San Diego, Mar. 1964.

In current practice involving drawings, a number of extremely important details are frequently not recorded by designers and metrologists. The omitted details include set-up and size, and are exemplified in an actual case history. A specification technique is described for specifying the origins of dimensions and the geometry of tolerances, and the application of the technique to the case history is shown. The advantages and disadvantages of Zero MMC tolerancing are outlined. (D.L.C.)

15694 (SC-TM-64-16) TRANSISTORIZED TELEPHONE PICKUP FOR A 1000-CYCLE-PER-SECOND STANDARD TONE. J. B. Gibbons (Sandia Lab., Albuquerque, N. Mex.). Feb. 1964. Contract [AT(29-1)-789]. 14p.

A telephone pickup developed to make the 1-kc standard frequency on the Sandia Base dial-telephone system readily available for calibration purposes at any location within Sandia Base is described. The transistor amplifier of the portable pickup unit is battery-powered and is tuned to 1 kc. (auth)

15695 (SC-TM-162-63-81) FRINGE-COUNTING READOUT SYSTEM FOR A LENGTH-MEASURING LASER INTERFEROMETER. C. M. Furnberg (Sandia Corp., Livermore Lab., Livermore, Calif.). Feb. 1964. Contract [AT(29-1)-789]. 12p.

A solid-state detection and readout system that counts fringes at a maximum rate of 250,000/sec was developed for use with a length-measuring laser interferometer. The system consists of a photodetector, a phase detector, and a bidirectional counter. In response to translation of a measuring probe, the interferometer produces interference fringes which appear as variations in light intensity. The photodetector senses these variations and converts them into two electrical signals. These signals have a phase difference of 90 degrees, either leading or lagging, depending on the direction in which the measuring probe is moving. The phase detector determines the phase relation and, for each quarter-cycle input from the photodetector, transmits a pulse to the appropriate channel (to indicate leading or lagging) of the bidirectional counter. The bidirectional counter displays continuously the algebraic difference between the number of pulses received on one channel and the number received on the other. Since each pulse corresponds to a displacement of about 1.6 microinches, the readout system indicates the number of 1.6-microinch increments by which the measuring probe of the interferometer was displaced from an arbitrary reference position. (auth)

15696 (SC-TM-366-63(72)) AN AIDED TRACKING ANALYSIS. D. R. Breding and H. V. Fisher (Sandia Lab., Albuquerque, N. Mex.). Jan. 1964. 9p. Contract AT (29-1)-789.

A method is discussed for determining the relationship between the parameters for a human-operator-controlled, aided tracking system. (auth)

15697 (SC-TM-375-63(14)) AN INVESTIGATION INTO THE PREPOTTING OF ELECTRICAL CONNECTORS. R. Corn, Jr., and F. X. Daut (Sandia Lab., Albuquerque, N. Mex.). Feb. 1964. Contract AT(29-1)-789. 9p.

An investigation was conducted into the contact splaying action due to lacing of cables on prepotted versus non-prepotted resilient insert connectors with pin protectors installed. This investigation demonstrated that the percentage of out-of-tolerance contacts is significantly smaller in the prepotted connector. (auth)

15698 (SCL-DC-2052) SIMPLE SUBMICROSECOND TRANSIENT SAMPLING TECHNIQUES. D. N. Bray and H. J. Jensen (Sandia Corp. Livermore Lab., Livermore, Calif.). Feb. 1964. Contract [AT(29-1)-789]. 19p. (CONF-401-1)

From Institute of Electrical and Electronics Engineers 1964 International Convention, New York, Mar. 1964.

A technique has been developed which allows the reconstruction of an unknown pulse up to about 1 microsecond long from a series of samples taken as often as every 10 nanoseconds, with sample apertures of the order of 2 to 15 nanoseconds. Samples may be accurate to 1 percent in amplitude, with sample times known to tenths of nanoseconds. Active electronic gating and timing circuitry is avoided. Output is maintained in an infinite-time-constant memory which can be interrogated at leisure allowing reconstruction of the unknown envelope. Some practical considerations are discussed which will help to evaluate applicability to special cases. (auth)

15699 (SCL-DR-64-2) RESULTS OF A TEST PROGRAM FOR FILAMENT-WOUND CYLINDERS. Charles T. Duffey, George R. Dunbar, and Lawrence H. Bakken (Sandia Corp., Livermore Lab., Livermore, Calif.). Jan. 1964. Contract AT(29-1)-789. 23p.

Presented are data accumulated from a test program in which thin-walled, filament-wound cylinders, cured at room temperature, were tested to destruction in axial tension, axial compression, and bending, with emphasis on tension and compression. Several room-temperature-curing resin systems were used; rovings included HTS 994 and hollow glass filaments. Wrap patterns included a 42-degree helix, a 20-degree helix plus circumferentials, and a nearly zero-degree helix plus circumferentials. Layup wrapping and winding under continuous tension of the zero-degree helicals is evaluated. All specimens were edge supported, and internal support by honeycomb is compared with no internal support. Instrumentation generally included deflectometer, load monitoring, and triaxial strain gages. (auth)

15700 (SRIA-109) HEAT CONTENTS OF MOLTEN ZINC CHLORIDE AND BROMIDE AND THE MOLECULAR CONSTANTS OF THE GASES. Technical Report No. XX. Daniel Cubicciotti and Harold Eding (Stanford Research Inst., Menlo Park, Calif.). Oct. 8, 1963. Contract AT(04-3)-106. 17p.

The heat contents of zinc chloride and bromide were measured from room temperature to about 700°C. The heat capacities (cal/mole deg) of the solids were: $14.5 + 5.5 \times 10^{-3}$ T and $12.6 + 10.4 \times 10^{-3}$ T °K; those of the liquid were 24.1 and 27.2 cal/mole; and the heats of fusion were 2.45 and 2.26 kcal/mole. These thermal data, when combined with the entropies of evaporation, resulted in absolute gaseous entropies that were 5 eu larger than the values calculated from molecular constant data. The discrepancy can be resolved if the molecules are bent or have lower bending frequencies than the literature values. (auth)

15701 (TID-18583) A GAS PRESSURE DISCHARGE TUBE FOR SEVERAL DIFFERENT LIQUID GAS CONTAINERS. S. Thunborg (Sandia Corp., Albuquerque, N. Mex.). Apr. 1963. Contract AT(29-1)-789. 3p. (SCDC-3187)

A discharge tube was developed to fit several different liquefied-gas containers. A rubber stopper was used to adjust to variations between neck openings. A method of compensating for variations in the depths of the containers was also incorporated. (M.C.G.)

15702 (TID-18653) THE SOLUBILITY OF P-IODOBENZENESULFONYL CHLORIDE. W. J. Blaedel and M. A. Evenson (Wisconsin. Univ., Madison). May 21, 1963. Contract AT(11-1)-1082. 10p.

The solubility of p-iodobenzenesulfonyl chloride was found by measuring the weight loss on passing water through a tube filled with the solid. Errors due to hydrolysis and incomplete saturation were avoided by finding a weight loss that was independent of flow rate. Solubilities were 16.6, 28.5, and 49.8 mg/l at temperatures of 25, 35, and 50°C, respectively. (auth)

15703 (TID-18659) STUDIES ON THE BIOLUMINESCENCE OF BALANOGLOSSUS BIMINIENSIS EXTRACTS. IV. THE KINETICS OF LUMINOL PEROXIDATION AND A PROPOSED MECHANISM FOR PEROXIDASE ACTION. Leon S. Dure and Milton J. Cormier (Georgia. Univ., Athens and Georgia. Univ., Sapelo Island. Marine Inst.). [1963]. Contract AT(40-1)-2741. 29p.

The kinetics of luminol peroxidation as catalyzed by horseradish peroxidase was investigated by determining the effect of H_2O_2 and luminol concentration on the rate of light production. Mechanisms of peroxidase action in the light-producing reaction in the organism Balanoglossus biminiensis are proposed. (C.H.)

15704 (TID-18662) STUDIES OF LIPOXIDASE ACTIVITY IN ETIOLATED MAIZE SEEDLINGS. George J. Fritz (Florida. Univ., Gainesville). [1962]. Contract AT(40-1)-2834. 28p.

The role of lipoxidase in biological oxygen fixation by plants is discussed. Data are presented from measurements of the contents of lipoxidase and lipoxidase substrates in etiolated maize seedlings. The effects of temperature, pH, and γ irradiation of maize embryos were investigated. (C.H.)

15705 (TID-20107) CELLULAR REACTIONS TO REINJECTION OF ANTIGEN. R. S. Speirs and E. E. Speirs (New York. State Univ., New York. Downstate Medical Center). [1963]. Contract [AT(30-1)-2916]. 18p.

Studies in mice showed that an injection of tritiated antigen resulted in an incorporation of radioactivity in neutrophils, eosinophils, and macrophages at different times during the inflammatory cycle. Necrosis of labeled cells was frequently observed, and the incorporated radioactive material was passed from cell to cell by phagocytosis. As the inflammation subsided, there was a marked decrease in the number of labeled cells in the exudate, and a concomitant appearance and persistence of labeled cells in lymph nodes, spleen, and bone marrow. The fate of these labeled cells was followed after re-exposure to antigen, using autoradiographic procedures. An intraperitoneal injection of tetanus or diphtheria toxoid at 10, 30, or 60 days after sensitization produced an increase in the total number of mononuclear cells and an increase in the mononuclear cells containing radioactive material. The labeled cells were found in all animals autopsied within 70 days of sensitization and in several animals autopsied approximately 270 days after sensitization. The labeled cells were macrophages or large lymphoid cells. Approximately 12% of these cells were multinucleated, usually binucleated. An attempt was made to develop a concept of antibody formation on a molecular level. It is postulated that lymphocytes, macrophages, and plasma cells act as carriers for the necessary template RNA and associated microsomes, whereas the eosinophiles, and possibly the neutrophiles, supply a means of transporting antigen and specific enzymatic material to the reacting cells, thereby initiating changes leading to hypersensitivity and antibody formation. (C.H.)

15706 (TID-20138) ACID NUCLEASES OF BEEF HEART TISSUE. (International Atomic Energy Agency, Vienna). [1963]. Contract AT(30-1)-2632. 12p.

The properties of acid RNAse and DNAse extracted from beef heart tissue were investigated as part of a study of the catalytic activities of heart lysosomes. Results indicate that the acid nucleases of heart tissue fulfill the main criteria requested by lysosomal enzymes. (C.H.)

15707 (TID-20144) INFLUENCE OF THE ENZYMIC DEGRADATION OF BEEF HEART LYSOSOMAL STRUCTURES UPON THE RELEASE OF SOME HYDROLASES ACTIVITIES. (International Atomic Energy Agency, Vienna). [1963]. Contract AT(30-1)-2632. 13p.

Acid hydrolase activities were determined in beef heart muscle lysosomes after enzymatic degradation of lysosomal structures with phospholipase A, trypsin, lysozyme, neuraminidase, hyaluronidase, and alkaline ribonuclease. The acid hydrolases determined after the enzymic degradation of heart lysosomes included β-galactosidase, β-glucuronidase, acid ribonuclease, and cathepsins. Results indicate that phospholipids contained in heart lysosomal structures mask the acid hydrolase catalytic activities. (C.H.)

15708 (TID-20218) METABOLISM OF LIPIDS IN THE DIGESTIVE TRACT OF THE SHEEP. R. M. C. Dawson (International Atomic Energy Agency, Vienna). [nd]. Contract AT(30-1)-2610. 5p.

Studies on fatty acid metabolism by sheep rumen microorganisms were performed in an artificial rumen under anerobic conditions using C^{14}-linolenic acid as a tracer. Fatty acids were extracted by solvent partitioning and analyzed by gas liquid chromatography using non-polar and polar columns, infrared spectroscopy, and a gas flow counter for determination of radioactivity. Results were compared with data from studies in intact sheep after the tracer was introduced into the rumen through a fistula or

by intravenous injection. The metabolism of fatty acids in the digestive tract of sheep is outlined. (C.H.)

15709 (TID-20251) A SENSITIVE METHOD FOR THE MEASUREMENT OF NONLINEARITY OF ELECTRICAL CONDUCTION. Charles E. Skov and Edgar Pearlstein (Nebraska Univ., Lincoln). [1963]. Contract AT(11-1)-525. 15p.

If an a-c potential $\nu = \nu_0 (\cos \omega t + \cos 2 \omega t)$ is applied to an element the current-voltage relation of which can be expressed as $I = a\nu + bV^2 + cV^3 + \ldots$, there will be a d-c component of the current proportional to the coefficient c. Equations are developed and apparatus is described for using this fact to measure deviations from Ohm's law. Experimental results show that deviations can be measured down to one part in 10^8. (auth)

15710 (TID-20253) ELECTROLYTIC OXIDATION OF URIC ACID: PRODUCTS AND MECHANISM. Report No. 81. William A. Struck and Philip J. Elving (Michigan. Univ., Ann Arbor. Dept. of Chemistry). Jan. 20, 1964. Contract AT(11-1)-1148. 35p.

Alloxan is the dominant product of the chemical oxidation of uric acid under strongly acid conditions; allantoin is the corresponding product for less acidic to alkaline conditions; separate reaction paths have generally been postulated to account for this difference. A study of the electrolytic oxidation of uric acid indicates the presence of a common path which eventually diverges to produce both alloxan and allantoin in comparable amounts. Uric acid gives a well-defined anodic voltammetric wave at a graphite electrode. When uric acid is electrolytically oxidized in dilute acetic acid at large graphite electrodes, 2.2 Faradays are passed, and 0.25 mole CO_2, 0.25 mole of a precursor of allantoin, 0.75 mole urea, 0.3 mole parabanic acid and 0.3 mole alloxan simultaneously appear per mole of uric acid oxidized. At any stage during electrolysis, the sum of the moles of allantoin precursor and urea equals the moles of uric acid oxidized. This material balance and the stability of the allantoin precursor indicate that the production of urea is associated with the pathway(s) that produce alloxan and parabanic acid. These and other facts indicate a mechanism whereby uric acid is oxidized in a 2e process to a primary short-lived intermediate, which undergoes three simultaneous transformations: (1) hydrolysis to the allantoin precursor, (2) hydrolysis to alloxan and urea, and (3) further oxidation and hydrolysis leading to parabanic acid and urea. The non-stoichiometric amount of CO_2 produced and the non-integral number of electrons involved are accounted for by the formation of parabanic acid. The primary oxidation intermediate ultimately produces both allantoin and alloxan, suggesting that this intermediate may be common to all uric acid oxidations and that the ultimate product heretofore considered to be typified by either allantoin or alloxan (but not both) is most likely controlled by experimental conditions. (auth)

15711 (TID-20256) QUARTERLY PROGRESS REPORT NO. 72 [ON ELECTRONICS]. H. J. Zimmermann and G. G. Harvey (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Jan. 15, 1964. Contract AT(30-1)-1842. 308p.

Research progress on radio physics, plasma dynamics, and communication sciences and engineering is summarized. (D.C.W.)

15712 (TID-20260) ANNUAL PROGRESS REPORT [ON TRANSPORT PROPERTIES OF ELECTROLYTE SYSTEMS], JANUARY 1, 1963–JANUARY 1, 1964. (Yale Univ., New Haven). Feb. 24, 1964. Contract AT(30-1)-1375. 16p.

Using the conductometric, restricted diffusion technique, the apparent diffusion coefficients of KCl in 10% methanol-water mixtures were measured over the region of interest in electrolyte theory. C^{14} diffusion coefficients for the heptane–benzene system at 25°C were determined. A calibration procedure for stirred diaphragm cells was developed for use with nonaqueous systems. Thermal diffusion in the n-hexadecane-heptane system was measured. Binary diffusion was studied in methanol–carbon tetrachloride systems. Investigations are being made of the temperature of maximum density of aqueous protein solutions. (M.C.G.)

15713 (TID-20262) AUTORADIOGRAPHIC INVESTIGATION OF BRAIN METABOLISM UNDER NORMAL, EXPERIMENTAL AND PATHOLOGICAL CONDITIONS. Annual Progress Report, June 15, 1963–February 15, 1964. Joseph Altman (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-3045. 7p.

Utilizing the technique of fine-resolution autoradiography, the incorporation of tritium-labeled precursors of DNA, RNA, and proteins by cells of the central nervous system in normal adult animals was studied during postnatal development, and under various experimental and pathological conditions. As an extension of these studies, an investigation was begun on the uptake of steroid hormones by cells in different parts of the brain. Labeled thymidine, a specific precursor of DNA, was used to study cell proliferation in brain-damaged rats, and in normal rats and cats. The global and regional patterns of cell multiplication in the brain during various phases of postnatal development is now being investigated, and also the possible effects of different conditions of maturation on cell multiplication. Special attention is given to the problem of postnatal multiplication of neurons. Experiments in progress indicate a high rate of postnatal proliferation of neurons in at least one (and possibly several other) forebrain structures in infant and young rats. Labeled leucine was used to study regional differences in the incorporation of this amino acid into proteins with the aid of quantitative microdensitometry. Severance of the optic tract was shown to produce increased utilization of leucine in pigeons and rats. Increase in the cellular utilization of leucine was observed in rats injected during exercise. The effects of visual and auditory stimulation on regional utilization of leucine is being investigated, and the effect of rearing animals in restricted and enriched environments. The diffusion of intraventricularly injected tritiated adenine, uracil and thymidine was investigated in cats and the conclusion was reached that contrary to the general view, the technique of intraventricular injection is not suitable for the uniform distribution of essential chemicals to the brain. The problem whether adenine can pass the blood-brain barrier is being investigated in an attempt to study regional differences in RNA metabolism as a consequence of physiological and behavioral manipulations. In pilot studies, tritium labeled testosterone and estradiol were injected into male and female rats, respectively, to study the regional binding of these sex hormones in the brain. Preliminary results indicate that testosterone is bound by cells in a few selective brain regions. (auth)

15714 (TID-20281) PHYSICAL MECHANISMS IN PHOTOSYNTHESIS. Gordon Tollin (Arizona. Univ., Tucson). [1963]. Contract AT(11-1)-908. 86p.

Physical mechanisms involved in primary processes in photosynthesis are reviewed. Emphasis is placed on photochemical reactions, energy transfer mechanisms, and the role of photosynthetic pigments and chlorophylls in primary photosynthetic processes. (C.H.)

15715 (TID-20322) NON-TIDAL DRIFT EXPERIMENTS OFF CAPE CANAVERAL DURING 1962. Reference No. 64-6. Final Report. Dean F. Bumpus (Woods Hole Oceanographic Institution, Mass.). Jan. 1964. Contract AT(30-1)-2972. 33p.

Studies of the non-tidal drift in the offing of Cape Canaveral were conducted during March-April and August 1962. Results from drift bottles, sea bed drifters, drogued telemetering buoys and moored current meters supported each other in revealing a predominantly northerly drift, during the March-April period, of approximately 12 cm/sec (0.23 kts) and a southerly drift during the August period of approximately 4-5 cm/sec (0.08 kts). During each period the drift was reversible. In March-April it was closely associated with the wind direction. When the wind sprang up from the south the current quickly turned northerly. When it hauled to the north it took a large fraction of a day to reverse the current direction. During the August period the relationship with the winds (normally lighter at this time than during the spring) was not obvious. The drift bottle and sea bed drifter experiments suggested that: when the water is not stratified, particulate matter with a density near that of sea water or material in solution will come ashore on the east coast of Florida within 30 days; when the water is stratified, material above the thermocline will come ashore, material below the thermocline having less tendency to do so until the thermocline is destroyed. Because of the reversing nature of the non-tidal current (i.e., short term aperiodic and long term periodic, northerly during November through June, southerly during July through October) the possibility of introduced material remaining in the area for a long time is high. (auth)

15716 (TID-20324) THE MATERIAL TRANSPORT MECHANISM DURING SINTERING OF COPPER POWDER COMPACTS AT HIGH TEMPERATURES. J. G. Early, F. V. Lenel, and G. S. Ansell (Rensselaer Polytechnic Inst., Troy, N. Y.). [1963]. Contract [AT(30-1)-1995]. 44p.

The isothermal shrinkage rates of copper powder compacts were determined in the temperature range from 760 to 1060°C. The rates for compacts from a pure spherical copper powder were compared, on the one hand, with those from a spherical powder with a dispersion of aluminum oxide in the copper matrix and, on the other hand, with those from a pure copper powder having irregularly shaped particles. The irregular copper powder compacts shrank much faster than the spherical copper powder compacts and these, in turn, shrank faster than dispersion strengthened copper powder compacts. The experiments were run under a small external load. By varying this load, the stress dependence of the isothermal shrinkage rate could be measured for compacts from spherical copper powders. This stress dependence was found to be approximately proportional to the 4th (Dispersion strengthened alloys) or 4.5th (pure metals) power of the stress. It is concluded that the material transport mechanism is due to dislocation climb rather than to Herring-Nabarro creep. (auth)

15717 (TID-20325) COMPLETE GENERAL SOLUTIONS OF THE PROBABILITY DISTRIBUTION FUNCTION FOR ALL 2, 3, 4, AND 5-STEP THREE-DIMENSIONAL RANDOM WALKS. Adon A. Gordus (Michigan. Univ., Ann Arbor. Dept. of Chemistry). Feb. 1964. Contract AT(11-1)-912. 76p.

The complete general solutions of the probability distribution function for the 2-, 3-, 4-, and 5-step three-dimensional random walks are presented. (C.E.S.)

15718 (TID-20328) BIREFRINGENCE CORRECTION FACTORS FOR THE SCATTERING OF LIGHT BY AN ANISOTROPIC SAMPLE. ONR Technical Report No. 47. R. S. Stein and S. N. Stidham (Massachusetts. Univ., Amherst. Polymer Research Inst.). July 5, 1962. Contract [AT(30-1)-2736]. 36p.

In order to obtain true scattering data from measured intensities in polymer films which have been rendered anisotropic by stretching, a correction must be made for the sample thickness and birefringence. Equations are derived for the intensities of the beam components, and they are programmed in FORTRAN for the IBM 1620 computer. (D.L.C.)

15719 (TID-20329) ON THE ORIENTATION MECHANISM OF CRYSTALLINE POLYMERS. ONR Technical Report No. 64. R. S. Stein and K. Sasaguri (Massachusetts. Univ., Amherst. Polymer Research Inst.). Sept. 4, 1963. Contracts [AT(30-1)-2736] and Nonr-3357(01). 37p.

A model involving the affine deformation of spherulites is developed for the change in crystal orientation with elongation of polymeric films. In the model, a detailed accounting is made of the orientation of individual crystal axes, and the effect of chain unfolding or crystal rotation within the spherulite is considered. The model successfully accounts for the experimental variation of birefringence and of crystal orientation functions with elongation. (D.L.C.)

15720 (TID-20330) THE TRANSMISSION OF CRYSTAL AGGREGATES BETWEEN POLARIZERS. ONR Technical Report No. 67. R. S. Stein and S. Clough (Massachusetts. Univ., Amherst. Polymer Research Inst.). Nov. 26, 1963. Contracts [AT(30-1)-2786] and Nonr-3357(01). 25p.

The presence of an optically anisotropic body between crossed polarizers generally results in the transmission of light; this effect can be used to study the kinetics of crystallization in oriented polymers. An analysis is made of the light transmission for an oriented polymer film between polaroids with their polarization directions set at an arbitrary angle. The effect of correlated orientation and the extension of the analysis to the geometry of a spherulite are considered. (D.L.C.)

15721 (TID-20331) THE KINETICS OF LOW-TEMPERATURE SINTERING OF LOOSE SILVER POWDER. M. J. Salkind, F. V. Lenel, and G. S. Ansell (Rensselaer Polytechnic Inst., Troy, N. Y.). [1963]. Contract [AT(30-1)-1995]. 29p.

A sintering experiment is described in which the growth of interparticle necks in an array of loose spherical silver powder at temperatures near 300°C was determined by measuring changes in the electrical resistance of the array. The activation energy for neck growth of contacts was derived by abruptly changing temperature and noting the change in the rate of neck growth. Since the experiments were run under an external load, the changes in activation energy with stress could be determined. The activation energy was found to decrease rapidly with increasing stress. It was concluded that the material transport in the experiments is one of plastic flow by dislocation motion. The variation of activation energy with stress is typical for cross slip of dislocations, an important material transport mechanism in the temperature range investigated. (auth)

15722 (TID-20332) THE INTERACTION BETWEEN PARTICLES AND A SOLID-LIQUID INTERFACE. D. R. Uhlmann, B. Chalmers (Harvard Univ., Cambridge, Mass. Gordon McKay Lab. of Applied Science); and K. A. Jackson (Bell Telephone Labs., Inc., Murray Hill, N. J.). [nd]. Contract [AT(30-1)-966]. 34p.

The interaction between particles and a solid-liquid interface was investigated both experimentally and theo-

retically. For a particular type of particle, a critical velocity was observed, below which the particles are rejected by the interface and above which they are trapped in the solid. The dependence of the critical velocity on various properties of matrix and particle was investigated. A theory was developed in terms of surface free energy, diffusion in the contact area between particle and solid, and viscous flow to the contact region. Reasonable assumptions produce satisfactory agreement between theory and experiment. (auth)

15723 (TID-20334) DEFECTS IN METALLIC AND IONIC CRYSTALS. Annual Report, March 15, 1963–March 15, 1964. A. S. Nowick (International Business Machines Corp. Thomas J. Watson Research Center, Yorktown Heights, N. Y.). Contract AT(30-1)-2811. 55p.

Zener Relaxation and Vacancy-Controlled Atomic Mobility in Ag–Zn Alloys. Anelastic relaxation in solid solutions of α Ag–Zn was used to follow vacancy annealing at extremely dilute vacancy concentrations. The temperature dependence of the relaxation time and the composition dependence of the activation and formation energies were determined for 23.5 to 33 at. % Zn alloys. Theory of Defect Relaxations. A theory was developed which uses the various types of relaxation to distinguish between defects of different symmetries and thus determine the structure of the defect. Thermodynamics of relaxation are considered. Equilibrium Study of Vacancies in Sodium. A high-precision interferometric dilatometer was developed for counting fringes automatically. The x-ray equipment and the specimen preparation for measurement of equilibrium concentration of vacancies in sodium at various temperatures are described. (D.L.C.)

15724 (UCRL-7273) ADDITION OF ACETALDEHYDE TO FLUOROETHYLENES. Eugene R. Bissell and Douglas B. Fields (California. Univ., Livermore. Lawrence Radiation Lab.). Feb. 25, 1963. Contract W-7405-eng-48. 13p.

Ultraviolet irradiation of gaseous mixtures of acetaldehyde and fluorinated ethylene resulted in complex mixtures of a ketone and an oxetane derived from addition of an acetyl radical to the CF_2 group of the olefin and by cycloaddition of the aldehyde to the olefin, respectively. Four olefins were studied: C_2F_4, C_2F_3Cl, C_2F_3Br, and 1,1-dichloro-2,2-difluoroethylene. The ketones and oxetanes were isolated by vapor-liquid partition chromatography, and their physical properties are tabulated. The structure of the products and the orientation of the additions were studied by means of nuclear magnetic resonance spectra. (D.L.C.)

15725 (UCRL-7557) IBM 1401 COMPUTER-PRODUCED AND -MAINTAINED LIBRARY CIRCULATION RECORDS. James H. Kennedy (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 23, 1964. Contract W-7405-eng-48. 7p.

A computer system for producing and updating tape files of circulation records is described. Manual files are eliminated. (D.C.W.)

15726 (UCRL-7672-T) THE CLASS OF SHOCKS WITH UNIFORM PRESSURES. John W. Hardy (California. Univ., Livermore. Lawrence Radiation Lab.). Dec. 1963. Contract W-7405-eng-48. 13p.

It is shown that for shock propagation at uniform velocity into a γ-law gas, there is a family of densities for which the material behind the shock is not accelerated. Further, these are the only densities with this property. (auth)

15727 (UCRL-7737-T) LRL FORTRAN-FORTRAN. S. Mendicino, D. Storch, and G. Sutherland (California. Univ., Livermore. Lawrence Radiation Lab.). Feb. 1964. Contract [W-7405-eng-48]. 16p.

Investigation showed that the FORTRAN language is sufficiently machine independent to allow the FORTRAN compiler to be written in FORTRAN. The output of the resultant compiler is inherently machine independent and may be efficiently directed to other machines by a suitable translation or assembly process. The operation of the compiler is described. (D.C.W.)

15728 (UCRL-10873) CHEMICAL ELEMENTS IN THE SERUM OF MAN IN HEALTH AND DIABETES MELLITUS. X-RAY EMISSION SPECTROGRAPHIC DETERMINATIONS (thesis). Lynn Richard Anspaugh (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1963. Contract W-7405-eng-48. 78p.

The use of the x-ray spectrograph in determining the levels of chemical elements in serum is discussed. Particular attention is devoted to the development of proper background correction formulas and tests of experimental reliability. These spectrographic and analytical techniques were used to determine the levels of 29 elements in a pooled serum powder sample of 125 healthy males and individual serum powder samples from 33 diabetic subjects. Limits of sensitivity varied from 0.01 to 24 μg/cc whole serum depending on the particular element studied. Diabetics were found to have significantly higher levels of P and K. A highly significant correlation between serum Cu levels and the age at onset of diabetes was found. There was not an inverse correlation between serum Cu and serum Fe levels as would be expected if this effect were due to fortuitous infections in the individuals with high serum Cu. The possible significance of these findings in the pathogenesis of diabetes is discussed. Four of the diabetics were found to have extremely low values of serum Fe although the Cu level was within normal limits. The possibility is raised that this may reflect poor control of their diabetes. (100 references.) (C.H.)

15729 (UCRL-Pub-48) STATUS REPORT [FOR] FISCAL YEAR 1963. (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Livermore. Lawrence Radiation Lab.). Contract W-7405-eng-48. 193p.

An accounting of current explorations in nuclear science at Lawrence Radiation Laboratory during the fiscal year 1963 is summarized. Information is included on: physics, chemistry, biology, medicine, biochemistry, inorganic materials, nuclear propulsion, Plowshare Project, Sherwood Project, nuclear weapons, engineering, data handling, personnel, administration, health physics, services rendered, and financial summary. (N.W.R.)

15730 NONNUCLEAR USES FOR DEPLETED URANIUM. H. Eschnauer (Nuklear-Chemie und -Metallurgie GmbH. Wolfgang, Ger.). Kerntechnik, 6: 22-5(Jan. 1964). (In German)

A check of literature shows that various different possibilities of application of uranium and uranium compounds have been pointed out rather early. In view of the large over-capacity of depleted uranium in the atomic age, sales of considerable quantities are desirable. Efforts concerning these matters and their possible success are discussed. (auth)

15731 NUCLEAR SAFETY. Volume 5, Number 2. William B. Cottrell, ed. (Oak Ridge National Lab., Tenn.). Winter 1963-1964. $0.70(GPO) (domestic), $0.90(GPO) (foreign). (One of the Technical Progress Reviews pre-

pared quarterly for the Division of Technical Information, USAEC).

A total of 16 review-type papers are presented on topics relevant to the analysis and control of hazards associated with reactors, fissionable materials, and fission products. The papers are arranged into sections dealing with general safety criteria, accident analysis, control and instrumentation, plant safety features, consequences of activity release, and current events. Separate abstracts were prepared for all of the papers. (D.L.C.)

For abstracts of individual papers see: 13434, 14045, 14253, 14254, 14255, 14583, 15435, 15455, 15456, 15479, 15572, 15573, 15600, 15633, 15634, and 15732.

15732 CHANGES IN LICENSING REGULATIONS. J. R. Buchanan. Nucl. Safety, 5: No. 2, 215-17(Winter 1963-64).

Changes were made or are being considered for the following AEC rules and regulations: statement of organization, delegations, and general information; public records; licensing of by-product materials; licensing of source material; special nuclear material; regulations to protect against accidental conditions of criticality in the shipment of special nuclear material; regulations to protect against radiation in the shipment of irradiated fuel elements; financial protection requirements and indemnity agreements; and exemptions and continued regulatory authority in agreement states. The changes are discussed individually. (D.L.C.)

CORPORATE AUTHOR INDEX

This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

Each entry under a corporate author is a shortened version of the title of the publication, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

The phrase "Progress report" is abbreviated as "Prog. rpt.," permitting a more rapid and complete alphabetical arrangement of the titles without changing the location of the progress report titles in relation to the other titles.

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æ	becomes	ae
ö		oe
ø		oe
ü		ue (except in transliterated Chinese names)

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The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium—isotopes He-4 or Helium—He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid—methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ξ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly with cross references under the element components. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

In this subject index specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract than would be possible with only a word or two whenever it appears that such information would be useful. Such phrases are written so that the idea considered most important is presented first, should a not-too-awkward expression result. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium—allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

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CONF-399–	**(Proceedings of the Symposium on Nuclear Spectroscopy, Argonne, Ill., March 1964)**	
1	18-15191	Dep.(mc); $1.10(fs), $0.80(mf) OTS
2	18-15192	Dep.(mc); $1.10(fs), $0.80(mf) OTS
CONF-400–	**(American Ordnance Association 19th Annual Meeting Standards and Metrology Division, San Diego, Calif., March 1964)**	
1	18-15693	See SC-R-64-105
CONF-401–	**(Institute of Electrical and Electronics Engineers 1964 International Convention, New York, March 1964)**	
1	18-15698	See SCL-DC-2052
CONF-402–	**(American Geophysical Union 43rd Annual Meeting, Washington, D. C., April 1962)**	
1	18-14092	ORINS
2	18-15034	ORINS
CONF-403–	**(Chemical Society of Japan 16th Annual Meeting, Tokyo, April 1963)**	
1	18-13833	Dep.(mc)
CONF-404–	**(International Conference on Non-Linear Magnetics, Washington, D. C., April 1964)**	
1	18-15344	See UCRL-7549-T
CONF-405–	**(4th Rare Earth Research Conference, Phoenix, Ariz., April 1964)**	
1	18-13622	See IS-825
2	18-14589	See IS-828
CONF-406–	**(2nd Annual High Temperature Liquid Metal Heat Transfer Technology Meeting, Upton, N. Y., May 1964)**	
1	18-14455	See CNLM-4094
CONF-407–	**(Electro Chemical Society, Toronto, May 1964)**	
1	18-13730	See UCRL-11195
CONF-408–	**(Interrelated Role of Federal Agencies and Universities in Nuclear Education Conference, Gatlinburg, Tenn., August 1963)**	
1	18-15670	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-130-3
CONF-410–	**(EAES Enlarged Symposium on Heterogeneous Heavy Water Power Reactors, Majorca, Spain, October 1960)**	
1	18-15577	ORINS
CONF-411–	**(2nd Symposium for Farm Editors, Muscle Shoals, Ala., September–October 1963)**	
1	18-15671	Dep.(mc); $1.60(fs), $0.80(mf) OTS
CONF-412–	**(Thermal Conductivity Conference, Gatlinburg, Tenn., October 1963)**	
1	18-15679	See IS-835
CONF-414–	**(Conference on Direct Energy Conversion, Argonne, Ill., November 1963)**	
1	18-14776	$1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-246-9
2	18-14777	Dep.(mc); $2.60(fs), $0.86(mf) OTS; Gmelin, AED-CONF-63-246-1

Report No.	Abstract No.	Availability
5	18-15411	ORINS. Gmelin, AED-CONF-63-246-8
6	18-14661	ORINS. Gmelin, AED-CONF-63-246-5
7	18-14451	ORINS. Gmelin, AED-CONF-63-246-4
CONF-415–	**(American Chemical Society 15th Annual Southeastern Regional Meeting, Charlotte, N. C., November 1963)**	
1	18-13908	ORINS. Gmelin, AED-CONF-63-251-1
2	18-13717	Dep.(mc); $2.60(fs), $0.92(mf) OTS; Gmelin, AED-CONF-63-251-2
CONF-416–	**(American Physical Society Division of Fluid Dynamics, Cambridge, Mass., November 1963)**	
1	18-14587	Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-226-6
CONF-417–	**(American Physical Society Meeting, Pasadena, Calif., December 1963)**	
1	18-14820	See UCRL-11163
2	18-15318	ORINS. Gmelin, AED-CONF-63-253-14
3	18-15320	ORINS. Gmelin, AED-CONF-63-253-15
5	18-14699	ORINS. Gmelin, AED-CONF-63-253-19
7	18-14664	ORINS. Gmelin, AED-CONF-63-253-3
8	18-15168	ORINS. Gmelin, AED-CONF-63-253-5
9	18-15035	ORINS. Gmelin, AED-CONF-63-253-9
10	18-15321	ORINS. Gmelin, AED-CONF-63-253-8
11	18-14963	ORINS. Gmelin, AED-CONF-63-253-10
12	18-15314	ORINS. Gmelin, AED-CONF-63-253-11
13	18-15193	Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-253-7
16	18-15315	ORINS. Gmelin, AED-CONF-63-2531
17	18-14713	ORINS. Gmelin, AED-CONF-63-253-12
CONF-424–	**(13th Annual Meeting of the Society of Physical Chemistry, Paris, June 1963)**	
1	18-15194	See EUR-483.e
CONF-425–	**(Conference on Nonfissile Metals for Nuclear Reactors, Bologna, December 1963)**	
1	18-14461	See EUR-589.f
CONF-426–	**(IAEA Study Group Meeting on Research Reactor Utilization, Athens, September 1963)**	
1	18-15483	See EUR-592.e
CONF-427–	**(American Chemical Society 146th National Meeting, Denver, January 1964)**	
1	18-13912	See HW-SA-2928
CONF-428–	**(National Association of Corrosion Engineers Conference, Kansas City, Mo., October 1963)**	
1	18-14401	See BNL-7553
CONF-429–	**(31st Annual Conference of Doble Clients, Boston, January 1964)**	
1	18-13996	See GAT-P-31
CONF-430–	**(Institute of Electrical and Electronics Engineers, Winter Power Meeting, New York, February 1964)**	
1	18-13996	See GAT-P-31
2	18-14795	ORINS
CONF-431–	**(Air Force Special Weapons Center, Albuquerque, N. Mex., April 1963)**	
1	18-14701	See LADC-5692
CONF-432–	**(Conference on Nuclear Physics, Claremont, Ferrand, France, June 1962)**	
1	18-14221	See UCRL-10317
CONF-433–	**(American Society Testing Materials, 1964 International Conference on Materials, Philadelphia, February 1963)**	
1	18-13615	Dep.(mc); $1.60(fs), $0.80(mf) OTS
CONF-434–	**(Surface Physics Symposium, Pullman, Wash., May 1963)**	
1	18-14727	See WERL-4
CONF-435–	**(XXV Annual Congress of the Group for Advancement of Spectroscopic Methods, Paris, June 1963)**	
1	18-13617	See EUR-478.f
CRDC–	**(Canadian)**	
1177	18-15604	Dep.; $0.50(AECL)
CU–	**(Misc.)**	
1304-1	18-13444	Dep.(mc); $1.10(fs), $0.80(mf) OTS
CVNA–	**(Misc.)**	
199	18-15517	Dep.(mc); $11.50(fs), $5.00(mf) OTS
200	18-15518	Dep.(mc); $3.60(fs), $1.28(mf) OTS
D–	**(Misc.)**	
1-82-0256	18-15325	
1-82-0323	18-15326	
1-82-0325	18-15327	
DLCS–		
5000164	18-15519	Dep.(mc); $6.60(fs), $2.03(mf) OTS
DMS–	**(Non-AEC)**	
63-10	18-15037	
DP–		
543	18-13616	Dep.(mc); $1.10(fs), $0.80(mf) OTS
837	18-14534	Dep.; $0.50(OTS)
846	18-14344	Dep.; $0.50(OTS)
850	18-13909	Dep.; $0.50(OTS)
851	18-14054	Dep.; $0.50(OTS)
878	18-14588	Dep.; $0.50(OTS)
885	18-15605	Dep.; $1.00(OTS)
895	18-15520	Dep.; $0.75(OTS)
DPR-INF–	**(British)**	
273	18-15521	Dep.(mc); Free(BIS)
DPST–		
64-69-1	18-14023	Dep.(mc); $1.10(fs), $0.80(mf) OTS
DRI–	**(Misc.)**	
2141	18-14457	
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
EGCR-STUDY–		
II-651	18-15541	See TID-20285
II-680	18-15540	See TID-20284
EIR–	**(Swiss)**	
49	18-14458	Dep.(mc)
EUR–	**(European Atomic Energy Community)**	
217.d(Pt. I and II)	18-15468	Dep.(mc)
358.i(Suppl.)	18-15130	Dep.(mc)
477.e	18-13834	Dep.(mc)
478.f	18-13617	Dep.(mc)
481.i	18-14072	Dep.(mc)
483.e	18-15194	Dep.(mc)
489.f	18-14105	Dep.(mc)
493.e	18-15469	Dep.(mc)
530.f	18-15470	Dep.(mc)
531.e	18-13618	Dep.(mc)
532.e	18-15131	Dep.(mc)

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543.e	18-15427	Dep.(mc)
549.f	18-15428	Dep.(mc)
550.f	18-14459	Dep.(mc)
582.d	18-13806	Dep.(mc)
584.f	18-14460	Dep.(mc)
589.f	18-14461	Dep.(mc); ORINS
592.e	18-15483	Dep.(mc)
594.d	18-13807	Dep.(mc)
EURAEC–		
53	18-14024	Dep.(mc); $6.60(fs), $2.09(mf) OTS
79	18-14357	Dep.(mc); $2.60(fs), $1.01(mf) OTS
95	18-14404	Dep.(mc); $9.10(fs), $3.23(mf) OTS
110	18-14160	Dep.(mc); $1.60(fs), $0.80(mf) OTS
114	18-14385	$3.60(fs), $1.22(mf) OTS
135	18-14358	Dep.(mc); $3.60(fs), $1.25(mf) OTS
136	18-14359	Dep.(mc); $2.60(fs), $1.10(mf) OTS
142	18-14405	Dep.(mc); $1.60(fs), $0.80(mf) OTS
153	18-14025	Dep.(mc); $12.00(fs), $5.18(mf) OTS
199	18-14360	Dep.(mc); $8.60(fs), $3.11(mf) OTS
226	18-14026	Dep.(mc); $1.10(fs), $0.80(mf) OTS
254	18-14361	Dep.(mc); $7.60(fs), $2.57(mf) OTS
317	18-14483	Dep.(mc); $2.60(fs), $0.89(mf) OTS
536	18-15497	Dep.(mc); $1.10(fs), $0.80(mf) OTS
596	18-15498	Dep.(mc); $9.60(fs), $3.56(mf) OTS
649	18-15499	Dep.(mc); $9.60(fs), $3.77(mf) OTS
785	18-14010	Dep.(mc); $1.60(fs), $0.80(mf) OTS
822	18-14386	Dep.(mc); $4.60(fs), $1.46(mf) OTS
850	18-14362	Dep.(mc); $3.60(fs), $1.22(mf) OTS
851	18-14462	Dep.(mc); $1.60(fs), $0.80(mf) OTS
852	18-14406	Dep.(mc); $2.60(fs), $0.83(mf) OTS
860	18-14387	Dep.(mc); $7.60(fs), $2.54(mf) OTS
861	18-14292	Dep.(mc); $2.60(fs), $1.07(mf) OTS
863	18-14545	Dep.(mc); $3.60(fs), $1.16(mf) OTS
869	18-14484	Dep.(mc); $1.60(fs), $0.80(mf) OTS
878	18-14535	Dep.(mc); $2.60(fs), $0.89(mf) OTS
889	18-15606	Dep.(mc); $1.60(fs), $0.80(mf) OTS
897	18-14038	Dep.(mc); $2.60(fs), $0.92(mf) OTS
898	18-14039	Dep.(mc); $5.60(fs), $1.79(mf) OTS
899	18-14040	Dep.(mc); $9.60(fs), $3.68(mf) OTS
900	18-14041	Dep.(mc); $7.60(fs), $2.36(mf) OTS
907	18-14435	Dep.(mc); $1.60(fs), $0.80(mf) OTS
908	18-14436	Dep.(mc); $3.60(fs), $1.22(mf) OTS
920	18-14030	See NYO-10489
928	18-14411	Dep.(mc); $1.60(fs), $0.80(mf) OTS
932	18-14463	Dep.(mc); $7.60(fs), $2.42(mf) OTS
942	18-15429	See GEAP-4482
961	18-14412	Dep.(mc); $1.60(fs), $0.80(mf) OTS
982	18-14021	See BAW-1291
983	18-14402	See CEND-202
FTD-TT–	**(Non-AEC)**	
63-1012	18-14388	OTS
63-1020	18-14413	OTS
GA–	**(Misc.)**	
3075	18-15607	
4071	18-14778	Dep.(mc); $9.60(fs), $3.59(mf) OTS
4729	18-14779	Dep.(mc); $5.60(fs), $2.00(mf) OTS
4838	18-15471	Dep.(mc); $2.60(fs), $0.92(mf) OTS
4874	18-14363	
GA-Phys–	**(Non-AEC)**	
63-7	18-15132	$7.60(OTS)
GAMD–	**(Misc.)**	
3513	18-15522	Dep.(mc); $6.60(fs), $2.18(mf) OTS
GAT-P–		
31	18-13996	Dep.(mc); $1.60(fs), $0.80(mf) OTS
GEAP–	**(Misc.)**	
4360	18-14536	Dep.(mc); $8.60(fs), $3.05(mf) OTS
4361	18-15487	Dep.(mc); $2.60(fs), $1.01(mf) OTS
4363	18-15523	Dep.(mc); $9.10(fs), $3.47(mf) OTS
4482	18-15429	Dep.(mc); $1.60(fs), $0.80(mf) OTS
GEMP–		
270C	18-15447	Dep.; $1.00(OTS)
GESR–		
2006	18-15488	Dep.(mc); $3.60(fs), $1.37(mf) OTS
2007	18-15489	Dep.(mc); $4.60(fs), $1.55(mf) OTS
GEST–	**(Misc.)**	
2025(Rev.1)	18-14780	
GIC–		
2605-1	18-14332	Dep.(mc); $8.60(fs), $3.14(mf) OTS
GNE/Phys–	**(Non-AEC)**	
63-9	18-14208	$7.60(OTS)
63-15	18-15472	$9.10(OTS)
HW–		
56675(Del.)	18-13910	Dep.(mc); $1.10(fs), $0.80(mf) OTS
66689	18-13619	$2.60(fs), $0.92(mf) OTS
70821	18-14364	Dep.(mc); $1.60(fs), $0.80(mf) OTS
74040	18-15654	$1.60(fs), $0.80(mf) OTS
76008	18-15524	Dep.; $0.50(OTS)
76606	18-13980	Dep.(mc); $2.60(fs), $0.83(mf) OTS
78435(Vol.I)	18-14578	Dep.; $3.00(OTS)
78456	18-15525	Dep.(mc); $3.60(fs), $1.16(mf) OTS
78892	18-13911	$1.60(fs), $0.80(mf) OTS
78948	18-13835	Dep.(mc); $2.60(fs), $1.04(mf) OTS
78956	18-14106	Dep.; $0.75(OTS)
79382	18-14579	Dep.; $3.00(OTS)
79522	18-14424	Dep.(mc); $2.60(fs), $0.98(mf) OTS
79553	18-14055	Dep.; $5.60(fs), $1.91(mf) OTS
79622	18-15655	Dep.; $0.75(OTS)
79695	18-15587	Dep.(mc); $1.10(fs), $0.80(mf) OTS
79738	18-13620	Dep.; $1.10(fs), $0.80(mf) OTS
79766	18-14365	Dep.; $2.75(OTS)
79814	18-15490	Dep.; $0.50(OTS)
80086	18-14066	Dep.(mc); $1.60(fs), $0.80(mf) OTS
80934	18-15672	Dep.(mc); $1.60(fs), $0.80(mf) OTS
HW-SA–		
2880	18-13718	Dep.(mc); $1.60(fs, $0.80(mf) OTS
2928	18-13912	Dep.(mc); $2.60(fs), $0.86(mf) OTS
2977	18-13403	Dep.(mc); $1.10(fs), $0.80(mf) OTS
3110	18-14368	Dep.(mc); $1.60(fs), $0.80(mf) JCL
3283	18-13913	Dep.(mc); $2.60(fs), $0.98(mf) OTS
3292	18-13518	Nature, 201: 721-2(1964)
3307	18-14056	Dep.(mc); $2.60(fs), $1.04(mf) OTS
3321	18-15608	Dep.(mc); $4.60(fs), $1.52(mf) OTS
3333	18-15656	Dep.(mc); $2.60(fs), $1.10(mf) OTS
3377	18-13914	Dep.(mc); $4.60(fs), $1.43(mf) OTS
I–	**(Misc.)**	
A2392-3	18-15528	See NYO-9788
IA–	**(Non-AEC)**	
796	18-13662	Israel J. Chem., 1: 86-90(1963)
817	18-13663	Israel J. Chem., 1: 136-41(1963)
IAE–	**(Russian)**	
517	18-15211	For translation see AEC-tr-6340
IDA-HQ–	**(Non-AEC)**	
63-1412(Vol.I)	18-13981	

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IDO–		
12032	18-14107	Dep.(mc); $3.60(fs), $1.22(mf) OTS
14613	18-13621	Dep.; $2.00(OTS)
16896	18-15609	Dep.; $0.75(OTS)
16932	18-15673	Dep.; $1.50(OTS)
IFA-HE–	**(Rumanian)**	
50	18-14802	Dep.(mc)
IMM-NYU–	**(Misc.)**	
316	18-15674	Dep.(mc); $4.60(fs), $1.61(mf) OTS
IPST-Cat–	**(Russian)**	
707	18-13464	For translation see OTS-63-11011
712	18-13464	For translation see OTS-63-11011
IS–		
530	18-15675	Dep.(mc); $7.60(fs), $2.57(mf) OTS
592	18-13808	Dep.(mc); $2.60(fs), $0.98(mf) OTS
631	18-13809	Dep.(mc); $1.10(fs), $0.80(mf) OTS
638	18-14369	Dep.(mc); $2.60(fs), $1.04(mf) OTS
641	18-15676	Dep.(mc); $1.10(fs), $0.80(mf) OTS
654	18-15677	Dep.(mc); $1.10(fs), $0.80(mf) OTS
667	18-13719	Dep.; $2.25(OTS)
669	18-14976	Ann. Phys. (N. Y.), 26: 307-21(1964)
727	18-13720	Dep.; $2.00(OTS)
728	18-13915	Dep.; $2.75(OTS)
730	18-15054	Phys. Rev., 134: A21-3(1964)
741	18-13721	Dep.; $2.50(OTS)
758	18-14752	p.295-7 of "Proceedings of the 1963 Midwest Conference on Theoretical Physics," Notre Dame, Ind., University of Notre Dame, 1963
762	18-14464	Dep.; $3.00(OTS)
770	18-13722	Dep.; $1.75(OTS)
790	18-15678	Dep.; $1.00(OTS)
810	18-14027	Dep.; $1.50(OTS)
825	18-13622	Dep.(mc); $1.60(fs), $0.80(mf) OTS
826	18-14633	Phys. Rev. Letters, 12: 281-4(1964)
828	18-14589	Dep.(mc); $2.60(fs), $0.86(mf) OTS
835	18-15679	Dep.(mc); $1.60(fs), $0.80(mf) OTS
ISU–	**(English)**	
10	18-14803	$3.60(OTS)
ITP–	**(Non-AEC)**	
98	18-14804	
JEN–	**(Spanish)**	
127-DF/I-39	18-15133	Dep.(mc)
128-DQ/I-38	18-14718	
JINR–	**(Russian)**	
E-1436	18-14805	Dep.(mc)
E-1496	18-14806	Dep.(mc)
E-1500	18-14965	Dep.(mc)
E-1503	18-14807	Dep.(mc)
E-1520	18-14808	Dep.(mc)
P-1453	18-14966	Dep.(mc)
P-1468	18-14209	Dep.(mc)
P-1486	18-15195	Dep.(mc)
P-1494	18-14809	Dep.(mc)
P-1498	18-14210	Dep.(mc)
P-1499	18-14211	Dep.(mc)
P-1506	18-14810	Dep.(mc)
P-1507	18-14673	Dep.(mc)
P-1508	18-14811	Dep.(mc)
P-1511	18-14812	Dep.(mc)
P-1516	18-14212	Dep.(mc)
P-1517	18-15043	Dep.(mc)
P-1526	18-14213	Dep.(mc)
P-1530	18-15196	Dep.(mc)
JPL-TM–	**(Non-AEC)**	
33-111	18-14700	$1.60(fs), $0.80(mf) OTS
JPRS–	**(Non-AEC)**	
22915	18-13458	$0.50(OTS)
23222	18-14132	$0.50(OTS)
23224	18-13459	$0.50(OTS)
23284	18-14133	$0.50(OTS)
23317	18-13579	$2.00(OTS)
23408	18-14167	$0.50(OTS)
23436	18-14594	$6.00(OTS)
23507	18-13460	$0.50(OTS)
23559(Del.)	18-13461	$1.25(OTS)
K–		
1303	18-13603	Dep.(mc); $1.60(fs), $0.80(mf) OTS
1590	18-13623	Dep.; $0.50(OTS)
KAPL–		
2296	18-14465	Dep.(mc); $4.60(fs), $1.55(mf) OTS
KAPL-M–		
6100	18-13982	Dep.(mc); $10.10(fs), $3.83(mf) OTS
6106	18-14028	Dep.(mc); $1.60(fs), $0.80(mf) OTS
6108	18-14029	Dep.(mc); $1.60(fs), $0.80(mf) OTS
JOS-2	18-14370	Dep.(mc); $1.60(fs), $0.80(mf) OTS
KR–	**(Norwegian)**	
63	18-13417	Dep.(mc)
65	18-14813	Dep.(mc)
LA–		
2989	18-14466	Dep.; $1.00(OTS)
3026	18-14345	Dep.; $0.75(OTS)
3035	18-13624	Dep.; $0.50(OTS)
LADC–		
5692	18-14701	Dep.(mc); $2.60(fs), $0.95(mf) OTS
5733	18-15680	Dep.(mc); $2.60(fs), $0.95(mf) OTS
5738	18-15681	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5744	18-14967	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5746	18-15682	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5749	18-15683	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5755	18-15684	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5764	18-15685	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5774	18-15686	Dep.(mc); $4.60(fs), $1.43(mf) OTS
5831	18-15270	Phys. Rev., 134: B16-22(1964)
5941	18-13749	Inorg. Chem., 3: 309-15(1964)
5956	18-15044	Dep.(mc); $3.60(fs), $1.28(mf) OTS
5987	18-15252	Phys. Rev., 133: B1401-3(1964)
6078	18-14498	J. Chem. Phys., 40: 1437-8(1964)
LAL–	**(French)**	
1053	18-13625	Dep.(mc)
LAMS–		
2963	18-15197	Dep.; $0.50(OTS)
2979	18-15198	Dep.(mc); $2.60(fs), $1.04(mf) OTS
3012	18-15484	Dep.; $1.00(OTS)
3027	18-15687	Dep.; $0.50(OTS)
LFEN–	**(Portuguese)**	
1	18-15610	Dep.(mc)
7	18-14719	Dep.(mc)
LNF–	**(Italian)**	
63/64	18-14674	Dep.(mc)
63/65	18-14214	Dep.(mc)
63/70	18-14675	Dep.(mc)

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63/73	18-14676	Dep.(mc)
63/74	18-14677	Dep.(mc)
LRP–	**(Swiss)**	
10-63	18-15328	Dep.(mc)
11-63	18-15329	Dep.(mc)
12-64	18-15330	Dep.(mc)
MATT–		
167	18-14161	Dep.(mc); $1.60(fs), $0.80(mf) OTS
225	18-15331	Dep.(mc); $1.60(fs), $0.80(mf) OTS
249	18-15332	Dep.(mc); $1.60(fs), $0.80(mf) OTS
MITS–		
51	18-13604	Dep.; $0.50(OTS)
ML–	**(Misc.)**	
1045	18-15339	See TID-19973
MLM–		
1152	18-15688	Dep.; $2.60(fs), $0.86(mf) OTS
1155	18-15689	Dep.; $4.60(fs), $1.49(mf) OTS
MMPP–	**(Misc.)**	
196	18-13445	Dep.(mc); $2.60(fs), $0.86(mf) OTS
MR-H–	**(Non-AEC)**	
212	18-15593	See NARF-58-28R
213	18-15594	See NARF-58-29R
222	18-15595	See NARF-58-40R
MRL–	**(Non-AEC)**	
397	18-14108	
MURA–	**(Misc.)**	
679	18-14678	Dep.; $2.25(OTS)
N–	**(Misc.)**	
63-14231	18-14702	$2.60(fs), $1.01(mf) OTS
63-16162	18-13983	See NASA-TN-D-1711
63-16291	18-14720	See NASA-TN-D-1720
63-17226	18-14700	See JPL-TM-33-111
63-17339	18-15017	$8.10(fs), $2.66(mf) OTS
63-19946	18-14757	$9.60(fs), $3.77(mf) OTS
63-19990	18-15420	$1.60(fs), $0.80(mf) OTS
63-20250	18-15333	$2.60(fs), $0.95(mf) OTS
63-20251	18-15334	$2.60(fs), $0.86(mf) OTS
63-22213	18-14540	See RAE-TM-SPACE-19
NAA-SR–		
7938	18-15590	Dep.; $0.50(OTS)
8610	18-15430	Dep.; $1.00(OTS)
8702	18-14371	Dep.; $0.50(OTS)
NAA-SR-Memo–		
8801	18-15431	Dep.(mc); $5.60(fs), $1.91(mf) OTS
9017	18-15134	Dep.(mc); $6.60(fs), $2.03(mf) OTS
9018	18-15135	Dep.(mc); $8.60(fs), $3.02(mf) OTS
9019	18-15136	Dep.(mc); $2.60(fs), $0.95(mf) OTS
9020	18-15137	Dep.(mc); $2.60(fs), $1.07(mf) OTS
9021	18-15138	Dep.(mc); $2.60(fs), $0.92(mf) OTS
9022	18-15199	Dep.(mc); $3.60(fs), $1.16(mf) OTS
9023	18-15139	Dep.(mc); $3.60(fs), $1.16(mf) OTS
9024	18-15140	Dep.(mc); $2.60(fs), $1.04(mf) OTS
9025	18-15141	Dep.(mc); $8.60(fs), $2.96(mf) OTS
9026	18-15142	Dep.(mc); $2.60(fs), $0.92(mf) OTS
9027	18-15143	Dep.(mc); $6.60(fs), $2.27(mf) OTS
9028(Rev.)	18-15200	Dep.(mc); $8.10(fs), $2.78(mf) OTS
9105	18-15591	$3.60(fs), $1.40(mf) OTS
9183	18-15448	Dep.(mc); $7.60(fs), $2.57(mf) OTS
9204	18-15144	$9.10(fs), $3.29(mf) OTS
9276	18-15145	Dep.(mc); $6.60(fs), $2.24(mf) OTS
9281	18-15449	Dep.(mc); $4.60(fs), $1.49(mf) OTS
9299	18-14425	Dep.(mc); $5.60(fs), $1.91(mf) OTS
9336	18-15450	Dep.(mc); $2.60(fs), $0.98(mf) OTS
9369	18-15526	Dep.(mc); $1.60(fs), $0.80(mf) OTS
9405	18-15592	Dep.(mc); $2.60(fs), $1.10(mf) OTS
9423	18-15432	Dep.(mc); $12.50(fs), $5.57(mf) OTS
NARF–	**(Non-AEC)**	
58-28R	18-15593	
58-29R	18-15594	
58-40R	18-15595	
NASA-CR–	**(Non-AEC)**	
50065	18-14700	See JPL-TM-33-111
54009	18-14785	
NASA-SP–	**(Non-AEC)**	
38	18-13988	$1.75(GPO)
NASA-TN–	**(Misc.)**	
D-1711	18-13983	$1.50(OTS)
D-1720	18-14720	$0.50(OTS)
D-2122	18-15421	$0.50(OTS)
D-2171	18-13997	$1.50(OTS)
NASA-TR–	**(Non-AEC)**	
R-178	18-15034	See CONF-402-2
R-192	18-14786	$1.00(OTS)
NBS-MON–	**(Misc.)**	
69	18-15422	$0.30(GPO)
NIRL-R–	**(British)**	
52	18-14679	Dep.(mc); $0.70(BIS); 3s. 6d. (HMSO)
57	18-14814	Dep.(mc); $1.20(BIS); 6s. (HMSO)
60	18-14590	Dep.(mc)
NMI–	**(Misc.)**	
2124	18-14372	Dep.(mc); $6.60(fs), $2.18(mf) OTS
NP–	**(AEC File No. for Non-AEC Reports)**	
13473	18-14073	Dep.(mc)
13498	18-14373	
13604	18-14109	$0.30(GPO)
13607	18-14162	Dep.(mc)
13608	18-14163	Dep.(mc)
13614	18-14680	Dep.(mc)
13616	18-14815	
13617	18-14681	Dep.(mc)
13618	18-14816	Dep.(mc)
13624	18-15335	
13626	18-15423	Dep.(mc)
13631	18-15336	Dep.(mc)
13640	18-13446	
13641	18-14215	Dep.(mc)
13644	18-14817	
13646	18-15337	
13648	18-15201	Dep.(mc)
13677	18-14818	Dep.(mc)
13678	18-15202	Dep.(mc)
13679	18-15203	Dep.(mc)
13680	18-14819	
13685	18-15657	
13686	18-15690	
13688	18-14110	Dep.(mc)
13702	18-14216	Dep.(mc)
13704	18-14703	Dep.(mc)
13719	18-15424	Dep.(mc)
13723	18-15527	

Report No.	Abstract No.	Availability
NP-tr-	**(AEC File No. for Non-AEC Translations)**	
1109	18-14297	Dep.(mc); $1.10(fs), $0.80(mf) JCL
1111	18-15500	Dep.(mc); $1.10(fs), $0.80(mf) JCL
NRC-	**(Canadian)**	
7744	18-15361	Can. J. Phys., 42: 548-62(1964)
7745	18-14604	Can. J. Phys., 42: 364-81(1964)
NRL-	**(Misc.)**	
F10	18-14073	See NP-13473
NYO-		
2315-1	18-13447	Dep.(mc); $1.10(fs), $0.80(mf) OTS
7243	18-14067	Dep.(mc); $19.75(fs), $9.71(mf) OTS
8590	18-15596	Dep.(mc); $10.10(fs), $3.92(mf) OTS
9788	18-15528	$28.50(fs), $21.11(mf) OTS
10025	18-13836	Dep.; $1.25(OTS)
10174	18-13626	Dep.; $2.25(OTS)
10330	18-13604	See MITS-51
10489	18-14030	Dep.(mc); $7.60(fs), $2.42(mf) OTS
10577	18-14031	Dep.(mc); $1.60(fs), $0.80(mf) OTS
OAD-RM-	**(Non-AEC)**	
106	18-14111	$9.10(OTS)
ORA-	**(Misc.)**	
5222-1-P	18-13445	See MMPP-196
ORINS-		
43	18-13390	Dep.; $2.25(OTS)
ORNL-		
3341	18-13723	Dep.; $1.25(OTS)
3460	18-14346	Dep.; $1.25(OTS)
3481	18-14591	Dep.; $1.25(OTS)
3503	18-15529	Dep.; $1.50(OTS)
3509	18-14061	Dep.; $0.75(OTS)
3513	18-14060	Dep.; $2.00(OTS)
3523	18-15530	Dep.; $5.50(OTS)
3535	18-13984	Dep.; $1.00(OTS)
3537	18-13627	Dep.; $2.75(OTS)
3541	18-14408	Dep.; $1.00(OTS)
3542	18-15433	Dep.; $0.75(OTS)
3547	18-14112	Dep.; $2.00(OTS)
3551	18-14409	Dep.; $2.00(OTS)
3554	18-14682	Dep.; $0.50(OTS)
3558	18-13916	Dep.; $2.50(OTS)
3560	18-15536	Dep.; $1.25(OTS)
3563	18-15691	Dep.; $1.50(OTS)
3567	18-14347	Dep.; $1.50(OTS)
3581	18-15692	Dep.; $0.50(OTS)
ORNL-TM-		
720	18-13448	Dep.(mc); $3.60(fs), $1.37(mf) OTS
767	18-14427	Dep.(mc); $2.60(fs), $0.89(mf) OTS
781	18-15473	Dep.(mc); $6.60(fs), $2.06(mf) OTS
790	18-15204	$13.00(fs), $5.72(mf) OTS
OTS-	**(Misc.)**	
64-21398	18-13458	See JPRS-22915
64-21556	18-14132	See JPRS-23222
64-21557	18-13459	See JPRS-23224
64-21591	18-14133	See JPRS-23284
64-21611	18-13579	See JPRS-23317
64-21660	18-14167	See JPRS-23408
64-21677	18-14594	See JPRS-23436
64-21708	18-13460	See JPRS-23507
64-21729(Del.)	18-13461	See JPRS-23559(Del.)
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
947,880	18-14191	
950,300	18-15653	
950,310	18-14012	
950,510	18-13803	
950,517	18-14013	
950,559	18-14286	
950,560	18-14287	
950,628	18-14452	
950,727	18-14014	
950,889	18-13804	
950,896	18-14288	
950,901	18-14015	
950,946	18-15461	
950,947	18-15462	
950,967	18-14016	
950,982	18-14017	
951,072	18-14289	
951,165	18-15463	
951,276	18-15464	
951,291	18-14192	
951,316	18-14290	
951,608	18-15465	
PATENTS	**(French)**	
1,323,725	18-15500	For translation see NP-tr-1111
PATENTS	**(German)**	
1,071,246	18-15660	For French translation see CEA-tr-A-1413
PATENTS	**(U. S.)**	
3,124,455	18-15127	
3,124,515	18-15509	
3,124,516	18-15466	
3,124,679	18-13713	
3,124,683	18-14665	
3,124,684	18-14291	
3,124,687	18-14573	
3,124,689	18-14058	
3,124,690	18-13991	
3,124,711	18-15170	
PATENTS	**(U.S.S.R.)**	
152,023	18-14193	
154,335	18-15418	
155,571	18-15419	
PG-Report-	**(British)**	
494	18-13639	Dep.
515	18-13640	Dep.; $0.50(BIS); 2s. 6d. (HMSO)
521	18-13641	Dep.
551	18-14580	Dep.; $0.80(BIS); 4s. (HMSO)
PR-P-	**(Canadian)**	
60	18-14592	Dep.; $1.50(AECL)
PUC-		
1963-116	18-15280	Phys. Rev., 134: B117-32(1964)
1963-119	18-14628	Phys. Rev., 134: B252-6(1964)
PWAC-	**(Misc.)**	
422	18-14164	Dep.; $2.75(OTS)
R-	**(Misc.)**	
2249	18-14462	See EURAEC-851
2255	18-14362	See EURAEC-850
RADC-TDR-	**(Misc.)**	
63-226	18-14539	$9.10(OTS)
RAE-TM-	**(British)**	
SPACE-19	18-14540	

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RD–	**(Misc.)**	
63-105	18-14428	
RFP–		
342	18-14375	Dep.; $0.50(OTS)
RISÖ–	**(Danish)**	
69	18-14217	Dep.(mc)
RM–	**(Misc.)**	
4031-PR	18-15018	
RRA–		
M31	18-15146	Dep.(mc); $3.60(fs), $1.13(mf) OTS
M32	18-15167	See CONF-187-91
M33	18-15166	See CONF-187-90
RRL–		
111	18-13838	Dep.(mc); $1.60(fs), $0.80(mf) OTS
RTD-TDR–	**(Non-AEC)**	
63-3051	18-14348	$15.00(OTS)
63-3086	18-14113	
63-3111	18-14721	
63-4130	18-14033	$16.50(OTS)
SB–	**(Non-AEC)**	
409(Suppl.1)	18-14376	$0.10(OTS)
SC–	**(Misc.)**	
4783(RR)	18-13642	Dep.; $2.00(OTS)
SC-DR–		
250-63	18-13643	Dep.(mc); $1.60(fs), $0.80(mf) OTS
316-63	18-14114	Dep.; $1.50(OTS)
SC-R–		
64-105	18-15693	Dep.(mc); $1.60(fs), $0.80(mf) OTS
SC-RR–		
64-70	18-14074	Dep.; $0.50(OTS)
SC-TM–		
64-16	18-15694	Dep.(mc); $1.60(fs), $0.80(mf) OTS
162-63-81	18-15695	Dep.(mc); $1.60(fs), $0.80(mf) OTS
366-63(72)	18-15696	Dep.(mc); $1.10(fs), $0.80(mf) OTS
375-63(14)	18-15697	Dep.(mc); $1.10(fs), $0.80(mf) OTS
SCDC–		
3187	18-15701	See TID-18583
SCL-DC–		
2052	18-15698	Dep.(mc); $1.60(fs), $0.80(mf) OTS
SCL-DR–		
64-2	18-15699	Dep.(mc); $2.60(fs), $0.89(mf) OTS
SCPRI(T)–	**(French)**	
98	18-14075	Dep.(mc)
SEL–	**(Misc.)**	
63-035	18-15341	See TID-20293
63-045	18-15340	See TID-20292
SIT–		
119	18-15338	Dep.(mc); $1.60(fs), $0.80(mf) OTS
SRIA–		
109	18-15700	Dep.(mc); $1.60(fs), $0.80(mf) OTS
SRO–		
99	18-15537	Dep.(mc); $1.60(fs), $0.80(mf) OTS
STI-DOC–	**(International Atomic Energy Agency)**	
10/22	18-14320	Radiation Control of Salmonellae in Food and Feed Products. Report of a Panel on Irradiation Control of Harmful Organisms Transmitted by Food and Feed Products, with Particular Reference to Salmonellae, Vienna, December 12–14, 1962; $3.00; Sch 63; 18 s.stg; F.fr. 12; DM 10.50 (IAEA)
55	18-15635	Utilization of Research Reactors. 1963. IAEA
STI-PUB–	**(International Atomic Energy Agency)**	
75(Vol.)	18-14330	$8.50; Sch 178.50; 51s.stg; F.fr.34,-; DM 29.75 (IAEA)
75(Vol.II)	18-14327	$7.00; Sch 147,-; 42s.stg; F.fr.28,-; DM 24.50 (IAEA)
SWRI–		
1321-1	18-15494	Dep.(mc); $1.10(fs), $0.80(mf) OTS
TAC-OA–	**(Non-AEC)**	
TM-121	18-14115	$1.60(OTS)
TID–		
3522(7th Rev.)	18-13992	Dep.; $1.25(OTS)
3577	18-14429	Dep.; $0.50(OTS)
4100(Suppl.20)	18-13985	Dep.; Free(DTIExtension)
4102	18-13986	Dep.; Free(DTIExtension)
7669	18-15434	Dep.; $2.25(OTS)
7676	18-14377	Dep.; OTS
7677	18-14116	Dep.; $7.00(OTS)
13636	18-13418	Dep.(mc); $2.60(fs), $1.07(mf) OTS
18581	18-13811	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18583	18-15701	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18592	18-14165	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18650	18-13726	$1.10(fs), $0.80(mf) OTS
18653	18-15702	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18659	18-15703	Dep.(mc); $2.60(fs), $1.07(mf) OTS
18662	18-15704	Dep.(mc); $2.60(fs), $1.04(mf) OTS
19541	18-15282	Phys. Rev., 134: B142-63(1964)
19568	18-14846	J. Chem. Phys., 40: 1396-1401(1964)
19635	18-15259	Phys. Rev., 133: B1483-94(1964)
19742	18-13590	J. Nucl. Med., 5: 139-53(1964)
19973	18-15339	Dep.(mc); $5.60(fs), $1.73(mf) OTS
20079	18-15598	Dep.; $0.30(GPO)
20099	18-14897	Phys. Rev. Letters, 12: 231-3(1964)
20103	18-15599	Dep.; $0.25(GPO)
20107	18-15705	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20132	18-15205	Dep.(mc); $5.60(fs), $1.91(mf) OTS
20136	18-15538	Dep.(mc); $2.60(fs), $1.01(mf) OTS
20138	18-15706	$1.60(fs), $0.80(mf) OTS
20139	18-13449	$1.60(fs), $0.80(mf) OTS
20142	18-15539	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20144	18-15707	$1.60(fs), $0.80(mf) OTS
20166	18-14034	Dep.(mc); $3.60(fs), $1.25(mf) OTS
20170	18-15147	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20201	18-13839	Dep.(mc); $5.60(fs), $1.94(mf) OTS
20203	18-13840	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20204	18-13605	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20205	18-13450	Dep.(mc); $2.60(fs), $0.86(mf) OTS
20206	18-15589	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20207	18-13451	$4.60(fs), $1.49(mf) OTS
20218	18-15708	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20219	18-13452	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20220	18-13453	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20221	18-14473	Dep.(mc); $2.60(fs), $1.10(mf) OTS

Report No.	Abstract No.	Availability
20223	18-13454	$1.10(fs), $0.80(mf) OTS
20224	18-15206	Dep.(mc); $4.60(fs), $1.46(mf) OTS
20225	18-15207	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20226	18-15208	Dep.(mc); $2.60(fs), $0.95(mf) OTS
20231	18-13455	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20232	18-13727	Dep.(mc); $2.60(fs), $0.98(mf) OTS
20233	18-14722	Dep.(mc); $5.60(fs), $1.88(mf) OTS
20236	18-13563	Dep.(mc); $2.60(fs), $0.83(mf) OTS
20237	18-14543	Dep.(mc); $8.10(fs), $2.81(mf) OTS
20238	18-14723	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20238(Paper 2)	18-14349	
20240	18-14593	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20241	18-13606	Dep.(mc); $7.60(fs), $2.39(mf) OTS
20242	18-13419	Dep.(mc); $2.60(fs), $0.86(mf) OTS
20244	18-14218	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20246	18-14219	Dep.(mc); $2.60(fs), $0.89(mf) OTS
20249	18-13812	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20251	18-15709	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20253	18-15710	Dep.(mc); $3.60(fs), $1.25(mf) OTS
20256	18-15711	Dep.(mc); $19.75(fs), $9.44(mf) OTS
20257	18-14350	Dep.(mc); $5.60(fs), $1.85(mf) OTS
20258	18-14351	Dep.(mc); $5.60(fs), $1.76(mf) OTS
20260	18-15712	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20262	18-15713	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20264	18-14474	Dep.(mc); $9.60(fs), $3.68(mf) OTS
20272	18-13391	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20281	18-15714	Dep.(mc); $8.10(fs), $2.78(mf) OTS
20284	18-15540	Dep.(mc); $4.60(fs), $1.70(mf) OTS
20285	18-15541	Dep.(mc); $22.25(fs), $12.44(mf) OTS
20292	18-15340	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20293	18-15341	Dep.(mc); $6.60(fs), $2.09(mf) OTS
20295	18-13841	Dep.(mc); $2.60(fs), $0.89(mf) OTS
20296	18-13842	Dep.(mc); $6.60(fs), $2.12(mf) OTS
20298	18-14724	Dep.(mc); $3.60(fs), $1.13(mf) OTS
20299	18-13456	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20300	18-14968	Dep.(mc); $2.60(fs), $1.01(mf) OTS
20301	18-14166	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20302	18-15474	Dep.(mc); $5.60(fs), $1.82(mf) OTS
20303	18-14725	Dep.(mc); $12.00(fs), $5.09(mf) OTS
20304	18-14475	Dep.(mc); $5.60(fs), $1.76(mf) OTS
20306	18-14704	Dep.; $5.00(OTS)
20307	18-14352	Dep.(mc); $4.60(fs), $1.49(mf) OTS
20316	18-15342	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20319	18-15584	Dep.(mc); $2.60(fs), $0.83(mf) OTS
20322	18-15715	Dep.(mc); $3.60(fs), $1.19(mf) OTS
20324	18-15716	Dep.(mc); $4.60(fs), $1.52(mf) OTS
20325	18-15717	Dep.(mc); $7.60(fs), $2.48(mf) OTS
20328	18-15718	Dep.(mc); $3.60(fs), $1.28(mf) OTS
20329	18-15719	Dep.(mc); $3.60(fs), $1.31(mf) OTS
20330	18-15720	Dep.(mc); $2.60(fs), $0.95(mf) OTS
20331	18-15721	Dep.(mc); $2.60(fs), $1.07(mf) OTS
20332	18-15722	Dep.(mc); $3.60(fs), $1.22(mf) OTS
20334	18-15723	Dep.(mc); $5.60(fs), $1.85(mf) OTS
20377	18-14035	Dep.(mc); $1.60(fs), $0.80(mf) OTS
TM–	**(Misc.)**	
3710-67	18-14353	See AD-408310
3831-67	18-14373	See NP-13498
62-10-14	18-14476	Dep.(mc); $3.60(fs), $1.40(mf) OTS
TR–	**(Misc.)**	
1109	18-15322	See AD-401695
TRG-Report–	**(Non-AEC)**	
636	18-15495	Dep.; $0.50(BIS); 2s. 6d. (HMSO)
708	18-13728	Dep.; $0.70(BIS); 3s. 6d. (HMSO)
UCLA-P–		
62	18-14684	Dep.(mc); $2.60(fs), $0.92(mf) OTS
UCOL–		
521	18-15209	Dep.(mc); $5.60(fs), $1.85(mf) OTS
UCRL–		
7043	18-14220	Dep.(mc); $3.60(fs), $1.16(mf) OTS
7273	18-15724	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7288	18-13729	Dep.(mc); $1.10(fs), $0.80(mf) OTS
7414	18-15343	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7498	18-15265	Phys. Rev., 134: A45-7(1964)
7532	18-14036	Dep.(mc); $8.10(fs), $2.69(mf) OTS
7549-T	18-15344	Dep.(mc); $2.60(fs), $0.86(mf) OTS
7557	18-15725	Dep.; $0.50(OTS)
7595	18-14477	Dep.; $1.25(OTS)
7611	18-15612	Dep.; $1.25(OTS)
7616	18-13644	Dep.; $0.50(OTS)
7672-T	18-15726	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7737-T	18-15727	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10317	18-14221	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10556	18-14037	Dep.(mc); $2.60(fs), $0.92(mf) OTS
10581	18-14478	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10586	18-14895	Phys. Rev. Letters, 12: 222-5(1964)
10626	18-14685	Dep.; $0.50(OTS)
10647	18-14726	Dep.(mc); $4.60(fs), $1.70(mf) OTS
10674	18-14479	Dep.(mc); $7.60(fs), $2.60(mf) OTS
10873	18-15728	Dep.; $2.00(OTS)
10930	18-15247	Phys. Rev., 133: B1373-80(1964)
11008	18-14875	Phys. Rev., 133: B1543-8(1964)
11054	18-15275	Phys. Rev., 134: B42-67(1964)
11146	18-14222	Dep.(mc); $1.10(fs), $0.80(mf) OTS
11163	18-14820	Dep.(mc); $1.60(fs), $0.80(mf) OTS
11170	18-14223	Dep.(mc); $2.60(fs), $0.83(mf) OTS
11193	18-15210	Dep.; $2.50(OTS)
11195	18-13730	Dep.(mc); $1.10(fs), $0.80(mf) OTS
11203	18-15286	Phys. Rev. Letters, 12: 195-8(1964)
11226	18-14062	Dep.(mc); $1.10(fs), $0.80(mf) OTS
11245	18-14224	Dep.(mc); $2.60(fs), $0.92(mf) OTS
11302	18-14225	Dep.(mc); $3.60(fs), $1.13(mf) OTS
UCRL-Pub–		
48	18-15729	Dep.(mc); $2.75(OTS)
132	18-14704	See TID-20306
UNC–	**(Misc.)**	
5062	18-15542	
5072	18-15425	Dep.(mc); $6.60(fs), $2.27(mf) OTS
UR–		
640	18-14130	Dep.; $2.60(fs), $0.83(mf) OTS
875-16	18-14890	Phys. Rev., 134: B235-9(1964)
875-20	18-14821	Dep.(mc); $1.60(fs), $0.80(mf) OTS
USAELRDL-TR–	**(Non-AEC)**	
2306	18-14544	$4.60(OTS)
USBM-U–	**(Misc.)**	
1091	18-14384	Dep.; $0.75(OTS)
USCEC–	**(Non-AEC)**	
82-208	18-15345	
USNRDL-TR–	**(Non-AEC)**	
705	18-13731	Dep.(mc); $2.60(fs), $1.07(mf) OTS
WAPD–	**(Misc.)**	
275	18-14480	Dep.; $1.25(OTS)
WAPD-T–		
1596	18-15155	Nucl. Sci. Eng., 18: 351-62(1964)
1599	18-15154	Nucl. Sci. Eng., 18: 163-76(1964)

Report No.	Abstract No.	Availability
WAPD-TM-	(Misc.)	
377	18-15148	Dep.; $1.75(OTS)
398	18-13987	Dep.; $1.50(OTS)
407	18-15149	Dep.; $1.00(OTS)

Report No.	Abstract No.	Availability
WERL-		
4	18-14727	
Y-		
1401	18-14131	Dep.; $2.25(OTS)

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RD–	(Misc.)	
63-105	18-14428	
RFP–		
342	18-14375	Dep.; $0.50(OTS)
RISÖ–	(Danish)	
69	18-14217	Dep.(mc)
RM–	(Misc.)	
4031-PR	18-15018	
RRA–		
M31	18-15146	Dep.(mc); $3.60(fs), $1.13(mf) OTS
M32	18-15167	See CONF-187-91
M33	18-15166	See CONF-187-90
RRL–		
111	18-13838	Dep.(mc); $1.60(fs), $0.80(mf) OTS
RTD-TDR–	(Non-AEC)	
63-3051	18-14348	$15.00(OTS)
63-3086	18-14113	
63-3111	18-14721	
63-4130	18-14033	$16.50(OTS)
SB–	(Non-AEC)	
409(Suppl.1)	18-14376	$0.10(OTS)
SC–	(Misc.)	
4783(RR)	18-13642	Dep.; $2.00(OTS)
SC-DR–		
250-63	18-13643	Dep.(mc); $1.60(fs), $0.80(mf) OTS
316-63	18-14114	Dep.; $1.50(OTS)
SC-R–		
64-105	18-15693	Dep.(mc); $1.60(fs), $0.80(mf) OTS
SC-RR–		
64-70	18-14074	Dep.; $0.50(OTS)
SC-TM–		
64-16	18-15694	Dep.(mc); $1.60(fs), $0.80(mf) OTS
162-63-81	18-15695	Dep.(mc); $1.60(fs), $0.80(mf) OTS
366-63(72)	18-15696	Dep.(mc); $1.10(fs), $0.80(mf) OTS
375-63(14)	18-15697	Dep.(mc); $1.10(fs), $0.80(mf) OTS
SCDC–		
3187	18-15701	See TID-18583
SCL-DC–		
2052	18-15698	Dep.(mc); $1.60(fs), $0.80(mf) OTS
SCL-DR–		
64-2	18-15699	Dep.(mc); $2.60(fs), $0.89(mf) OTS
SCPRI(T)–	(French)	
98	18-14075	Dep.(mc)
SEL–	(Misc.)	
63-035	18-15341	See TID-20293
63-045	18-15340	See TID-20292
SIT–		
119	18-15338	Dep.(mc); $1.60(fs), $0.80(mf) OTS
SRIA–		
109	18-15700	Dep.(mc); $1.60(fs), $0.80(mf) OTS
SRO–		
99	18-15537	Dep.(mc); $1.60(fs), $0.80(mf) OTS
STI-DOC–	(International Atomic Energy Agency)	
10/22	18-14320	Radiation Control of Salmonellae in Food and Feed Products. Report of a Panel on Irradiation Control of Harmful Organisms Transmitted by Food and Feed Products, with Particular Reference to Salmonellae, Vienna, December 12–14, 1962; $3.00; Sch 63; 18 s.stg; F.fr. 12; DM 10.50 (IAEA)
55	18-15635	Utilization of Research Reactors. 1963. IAEA
STI-PUB–	(International Atomic Energy Agency)	
75(Vol.)	18-14330	$8.50; Sch 178.50; 51s.stg; F.fr.34,-; DM 29.75 (IAEA)
75(Vol.II)	18-14327	$7.00; Sch 147,-; 42s.stg; F.fr.28,-; DM 24.50 (IAEA)
SWRI–		
1321-1	18-15494	Dep.(mc); $1.10(fs), $0.80(mf) OTS
TAC-OA–	(Non-AEC)	
TM-121	18-14115	$1.60(OTS)
TID–		
3522(7th Rev.)	18-13992	Dep.; $1.25(OTS)
3577	18-14429	Dep.; $0.50(OTS)
4100(Suppl.20)	18-13985	Dep.; Free(DTIExtension)
4102	18-13986	Dep.; Free(DTIExtension)
7669	18-15434	Dep.; $2.25(OTS)
7676	18-14377	Dep.; OTS
7677	18-14116	Dep.; $7.00(OTS)
13636	18-13418	Dep.(mc); $2.60(fs), $1.07(mf) OTS
18581	18-13811	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18583	18-15701	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18592	18-14165	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18650	18-13726	$1.10(fs), $0.80(mf) OTS
18653	18-15702	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18659	18-15703	Dep.(mc); $2.60(fs), $1.07(mf) OTS
18662	18-15704	Dep.(mc); $2.60(fs), $1.04(mf) OTS
19541	18-15282	Phys. Rev., 134: B142-63(1964)
19568	18-14846	J. Chem. Phys., 40: 1396-1401(1964)
19635	18-15259	Phys. Rev., 133: B1483-94(1964)
19742	18-13590	J. Nucl. Med., 5: 139-53(1964)
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20099	18-14897	Phys. Rev. Letters, 12: 231-3(1964)
20103	18-15599	Dep.; $0.25(GPO)
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20132	18-15205	Dep.(mc); $5.60(fs), $1.91(mf) OTS
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20225	18-15207	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20226	18-15208	Dep.(mc); $2.60(fs), $0.95(mf) OTS
20231	18-13455	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20232	18-13727	Dep.(mc); $2.60(fs), $0.98(mf) OTS
20233	18-14722	Dep.(mc); $5.60(fs), $1.88(mf) OTS
20236	18-13563	Dep.(mc); $2.60(fs), $0.83(mf) OTS
20237	18-14543	Dep.(mc); $8.10(fs), $2.81(mf) OTS
20238	18-14723	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20238(Paper 2)	18-14349	
20240	18-14593	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20241	18-13606	Dep.(mc); $7.60(fs), $2.39(mf) OTS
20242	18-13419	Dep.(mc); $2.60(fs), $0.86(mf) OTS
20244	18-14218	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20246	18-14219	Dep.(mc); $2.60(fs), $0.89(mf) OTS
20249	18-13812	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20251	18-15709	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20253	18-15710	Dep.(mc); $3.60(fs), $1.25(mf) OTS
20256	18-15711	Dep.(mc); $19.75(fs), $9.44(mf) OTS
20257	18-14350	Dep.(mc); $5.60(fs), $1.85(mf) OTS
20258	18-14351	Dep.(mc); $5.60(fs), $1.76(mf) OTS
20260	18-15712	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20262	18-15713	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20264	18-14474	Dep.(mc); $9.60(fs), $3.68(mf) OTS
20272	18-13391	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20281	18-15714	Dep.(mc); $8.10(fs), $2.78(mf) OTS
20284	18-15540	Dep.(mc); $4.60(fs), $1.70(mf) OTS
20285	18-15541	Dep.(mc); $22.25(fs), $12.44(mf) OTS
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20293	18-15341	Dep.(mc); $6.60(fs), $2.09(mf) OTS
20295	18-13841	Dep.(mc); $2.60(fs), $0.89(mf) OTS
20296	18-13842	Dep.(mc); $6.60(fs), $2.12(mf) OTS
20298	18-14724	Dep.(mc); $3.60(fs), $1.13(mf) OTS
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20324	18-15716	Dep.(mc); $4.60(fs), $1.52(mf) OTS
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20329	18-15719	Dep.(mc); $3.60(fs), $1.31(mf) OTS
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20332	18-15722	Dep.(mc); $3.60(fs), $1.22(mf) OTS
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20377	18-14035	Dep.(mc); $1.60(fs), $0.80(mf) OTS
TM-	(Misc.)	
3710-67	18-14353	See AD-408310
3831-67	18-14373	See NP-13498
62-10-14	18-14476	Dep.(mc); $3.60(fs), $1.40(mf) OTS
TR-	(Misc.)	
1109	18-15322	See AD-401695
TRG-Report-	(Non-AEC)	
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